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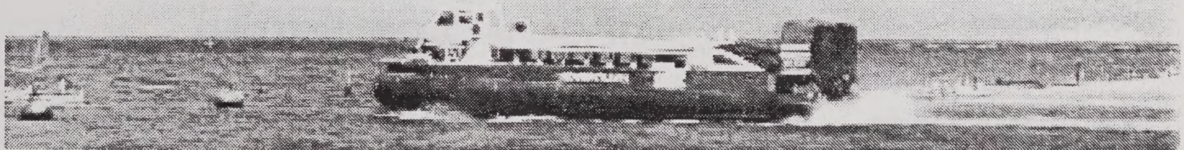
FINAL REPORT

AIRPORT FERRY STUDY 1998:
A FEASIBILITY STUDY OF WATER TRANSIT SERVICE TO SAN FRANCISCO INTERNATIONAL AIRPORT



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MAY 29, 1998

PREPARED BY:
PACIFIC TRANSIT MANAGEMENT
BERKELEY, CALIFORNIA

This report was sponsored by Airport Commission of the City and County of San Francisco. The report follows from a previous Airport Ferry Study conducted by Pacific Transit Management Corporation in 1993, also on behalf of the Airport Commission.

Airport Commission
City and County of San Francisco

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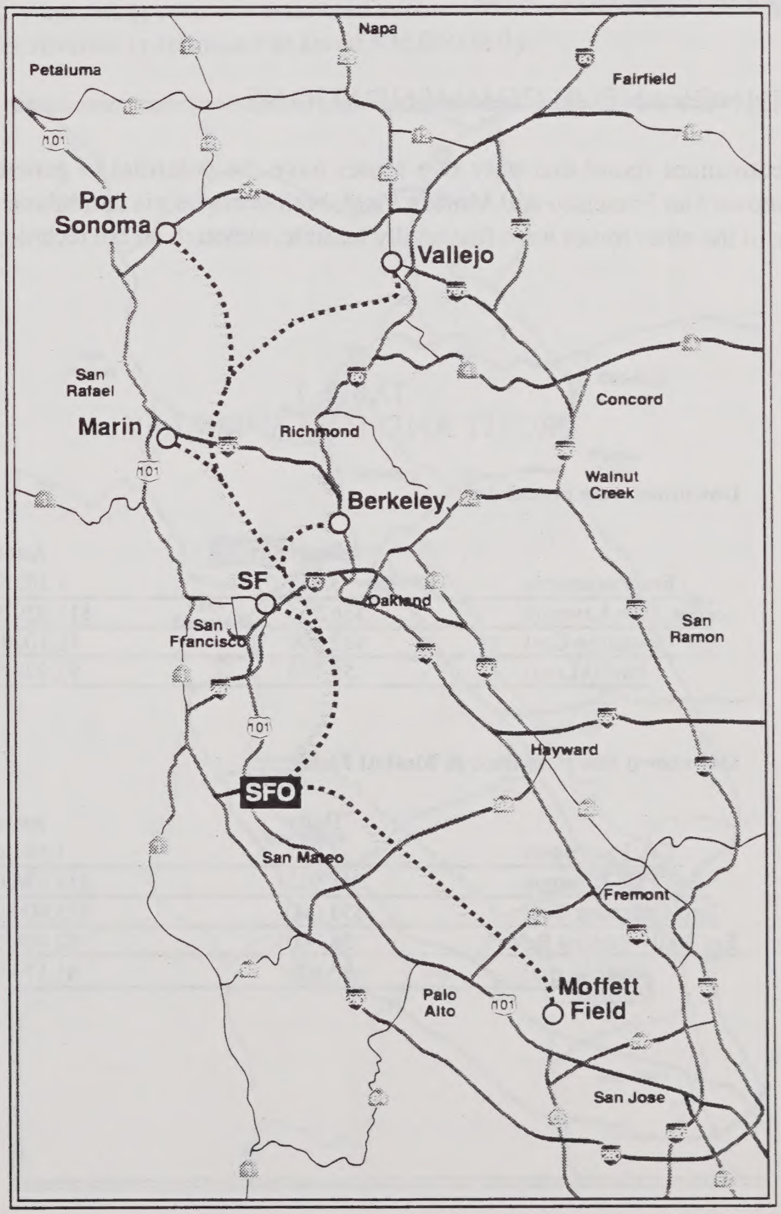
EXECUTIVE SUMMARY

OVERVIEW

The Airport Commission retained Pacific Transit Management Corporation to study the feasibility of waterborne transit service between the airport and various Bay Area ports. Six routes were studied:

Downtown San Francisco	Moffett Field
Marin County (Larkspur)	Port Sonoma
Vallejo	Berkeley



Pursuant to directions from airport staff, the consultant's mission was to identify routes that could be operated by the private sector at a profit. Therefore, no operating subsidy was assumed, although various forms of equipment subsidy were considered.

The Airport Commission initiated a "Peer Review" of the study and the consultant's efforts at about the one-third point in the study. Most suggestions of the "Peer Group" have been included in the final report.

Two distinct ferry "modes-of-operation" were reviewed: conventional ferry requiring a transfer to shuttle buses at the Airport's Seaplane Harbor, and amphibious hovercraft which would operate across the airfield to a terminal at an airline gate and requires no transfer.

The study comprises three distinct elements: market demand, financial feasibility, and operational feasibility.

FINDINGS AND RECOMMENDATIONS

The consultant found that only two routes have the potential to generate a profit: Downtown San Francisco and Moffett Field, both operated via amphibious hovercraft. None of the other routes were financially feasible, although all are technically feasible.

TABLE 1
PROFIT AND LOSS SUMMARY

Downtown San Francisco

	Daily	**Annual**
Est. Passengers	3,675	1,102,950
Est. Fare Revenue	$36,765	$11,029,500
Est. Operating Cost	$27,000	$8,100,000
Profit/(Loss)	$9,765	$2,929,500

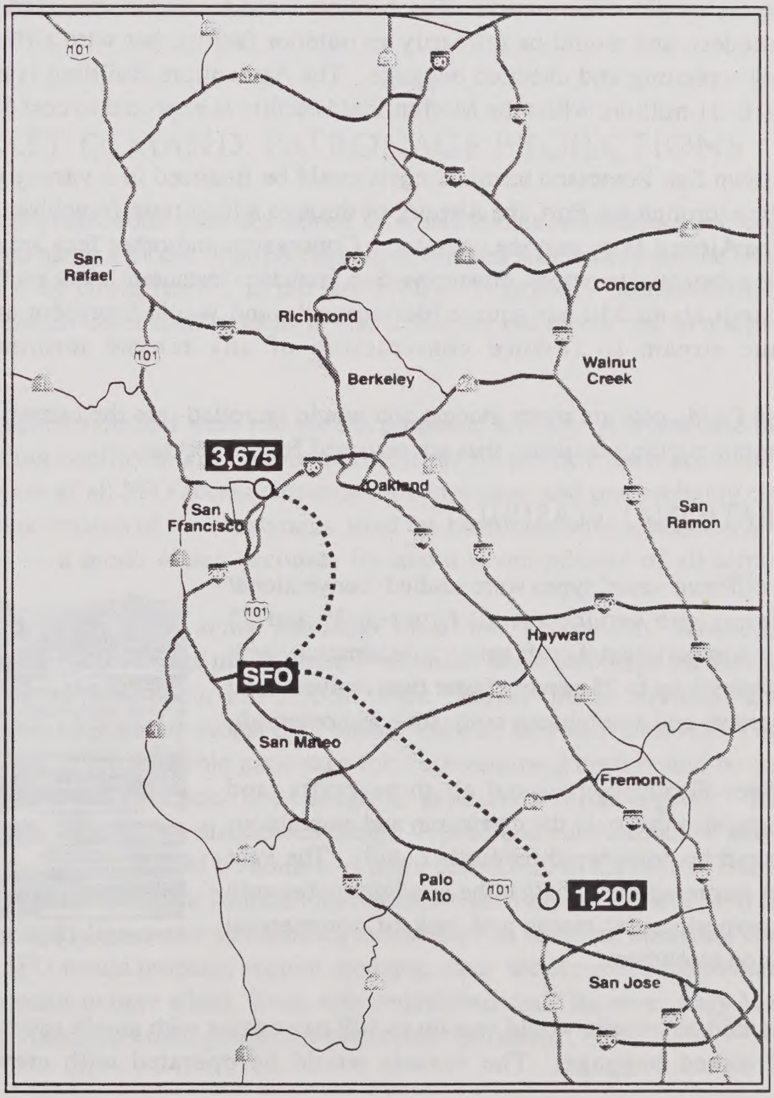
Downtown San Francisco & Moffett Field

	Daily	**Annual**
Est. Passengers	4,875	1,467,608
Est. Fare Revenue	$48,920	$14,676,075
Est. Operating Cost	$53,000	$15,900,000
Est. Daily Parking Rev.	$8,000	$2,400,000
Profit/(Loss)	$3,920	$1,176,075

CANDIDATE ROUTES : DOWNTOWN SAN FRANCISCO AND MOFFETT FIELD

The Downtown San Francisco route is estimated to carry between 3,200 and 3,800 passengers daily and would operate from the Agriculture Building, at the foot of Mission Street. The market share (modal split) for the ferry service would be about 16 percent of all air passenger trips between downtown and the Airport. Service would be provided via amphibious hovercraft, operating every 20 minutes, 16 hours daily. At other times, the service provider may use alternative arrangements (bus, etc.). Passengers would access the airport terminals directly, and a hovercraft terminal would be provided at SFO's North Terminal.

Vessel capital costs are estimated at about $30 million, or about $157 per operating hour. Vessel operating costs are estimated at about $410: Total fully allocated capital and hourly operating costs are estimated at about $567, or about $27,000 daily. Total passenger revenue is estimated at about $36,000 daily.



The Moffett Field route is estimated to carry between 1,000 and 1,200 passengers daily and would operate from a new site near the Moffett Field Golf Course. The market share (modal split) for the ferry service would be about seven percent of all air passenger trips between northern Santa Clara County and the Airport. Service frequencies would mirror the Downtown San Francisco service.

Vessel capital costs are estimated at about $ 37 million. It is assumed that this route would be operated in conjunction with the downtown San Francisco route. This joint operation would reduce the fully allocated hourly cost to about $489, and would allow a profitable operation for both services initially, with the downtown service essentially cross-subsidizing the Moffett Field service in the early years.

Facility and terminal costs are significant. The service concept envisions a complete satellite airport terminal at each location. Airline counters, checked baggage and security screening would all be provided. In addition, the Agriculture Building requires significant seismic upgrading and is expected to require major modifications to function as a modern transportation terminal — its costs are based on about 6,000 daily passengers to allow for growth. The Moffett Field facility is expected to be much more modest, and would be primarily an outdoor facility, but with airline counters, security screening and checked baggage. The Agriculture Building is estimated to cost $10 -11 million, while the Moffett Field facility is expected to cost $2-3 million.

Downtown San Francisco terminal costs could be financed in a variety of methods, including through the Port, the Airport, or through a long-term franchise arrangement with the Airport ferry service operator. Concession and other fees are expected to provide substantial revenues; downtown San Francisco restaurant space on Port property commands about $30 per square foot annually and would represent an important revenue stream to finance construction of any remote terminal facility.

Moffett Field costs are more modest and would be rolled-into the overall costs of the automobile parking facilities that are assumed for the service.

OPERATIONAL FEASIBILITY

Three different vessel types were studied: conventional catamaran with service speeds between 30 and 35 knots; an experimental craft called a quadmaran, with vessel speeds up to 25 percent faster than conventional catamarans; and amphibious craft, such as hovercraft.

The Peer Group considered all three crafts, and recommended that only the catamaran and amphibious hovercraft be considered for further study. The Peer Group recommended against the quadmaran because of its experimental status and lack of commercial operation elsewhere.


Hovercraft operating in England

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The candidate vessels would seat up to 149 passengers with ample room for carry-on and checked baggage. The vessels would be operated with crews of three.

Both hovercraft and catamaran have similar marginal operating costs — about $250 - $275 per hour. However, the capital cost of a hovercraft is significantly more expensive. A catamaran would cost about $6 million per vessel, but this analysis assumes that hovercraft will cost about $7.5 million per vessel, or about 25 percent more. However, hovercraft do not require buses to transfer passengers at the airport end of the system, creating a minor cost savings.

A key concern of the Peer Group was the ability of hovercraft to navigate across the airfield. This analysis assumes that the hovercraft will require a tug to secure the craft during its journey across the field, but that otherwise the craft can safely operate on the airport's taxiways. The analysis assumes that there is no crossing of airport runways. In addition, noise issues and terminal siting issues at Moffett Field will require further analysis and engineering work, although these issues can be solved.

These assumptions would be tested during a planned Summer 1998 demonstration of hovercraft technology. The airport has requested a demonstration of a Canadian hovercraft. The Westland Aerospace AP1-88-400 hovercraft, in freighter configuration, would test the operational suitability of the amphibious vessel concept for a one week period.

MARKET DEMAND: PATRONAGE PROJECTIONS

Patronage projections were developed by Ann Stevens Associates. Projections were developed using a model of airport access developed specifically for the Bay Area and published by Greig Harvey in the late 1980's. A primary limitation of the airport model, and all other such models, is that ferries are not developed as a separate mode choice.

Therefore, two models were run for the proposed service. A worst case model used the existing coefficients for public transit users — public transit accounts for about one percent of all SFO access currently. A better case, and one probably closer to the actual expectations of the consultants, used the coefficients for scheduled airporter bus services — a mode which accounts for about seven percent of all airport access.

The study assumes that actual patronage under the "no-transfer" hovercraft options will be about 95 percent of the "Airporter" estimate, while patronage for the conventional craft option will be about 150 percent of the "transit" mode estimate. The transfer times involved in conventional craft clearly indicate that such a service is not a viable option. Highest reasonable patronage for a conventional craft would be about 1,700 daily from San Francisco, not enough to generate a reliable profit. In contrast, amphibious craft have a distinct advantage – speed and convenience – and patronage using these vessels would be double — more than 3,600 in the case of San Francisco. It should be noted that the Moffett Field operation can only be operated with amphibious craft due to shallow water surrounding the facility. In addition, operating conventional craft to SFO would probably require dredging, since the channel marked on navigation charts appears to have silted. Even with amphibious craft, however, only Moffett Field and San Francisco could generate a profitable operation.

TABLE 2
AIRPORT FERRY PATRONAGE PROJECTIONS

Terminal	Service Type	Service Frequency	Transit Output	"Airporter" Output	Estimated Patronage
San Francisco	Conventional	20 min	1169	2699	1754
	Conventional	30 min	974	2273	1461
	Amphibious	20 min	1605	3870	3675
	Amphibious	30 min	1327	3605	3424
Moffett Field	Conventional	20 min	248	752	371
	Conventional	30 min	203	635	305
	Amphibious	20 min	399	1280	1200
	Amphibious	30 min	332	1224	1163
Marin	Conventional	20 min	234	340	351
	Conventional	30 min	223	309	334
	Amphibious	20 min	269	508	482
	Amphibious	30 min	252	498	473
Berkeley	Conventional	20 min	111	334	167
	Conventional	30 min	92	270	137
	Amphibious	20 min	160	609	579
	Amphibious	30 min	131	576	547
Port Sonoma	Conventional	20 min	58	228	87
	Conventional	30 min	47	180	71
	Amphibious	20 min	98	617	586
	Amphibious	30 min	122	606	576
Vallejo	Conventional	20 min	56	200	84
	Conventional	30 min	46	159	69
	Amphibious	20 min	107	568	539
	Amphibious	30 min	123	561	533

The patronage model does not assume a checked baggage facility at either the Agriculture Building or at Moffett Field — it can be speculated that such a facility would increase patronage for the service, but the amount of increase is uncertain. The model additionally assumes no transfers between a downtown San Francisco Airport ferry and any of the existing ferries operating to Vallejo, Marin, Oakland or Alameda. Should a reasonable transfer rate be assumed, then it is possible that at least 500 daily passengers would use such a service. These 500 additional passengers would generate another $5,000 in fares daily for the Airport Ferry Service. Finally, the model is only built upon the patronage estimated from Bay Area residents. This population makes up only 40 percent of SFO users — the model therefore ignores the potential market of visitors to the Bay Area, who make up 60 percent of SFO users. The model is therefore conservative.

FREIGHT AND CARGO POSSIBILITIES

In addition to passenger operation, three distinct freight and cargo markets appear suited for Airport Ferry services. The best SFO market appears to be "belly cargo," especially international high value freight. Both the Moffett Field area and downtown San Francisco appear to be significant shippers or end users of such products; the South Bay generates about 500 metric tons daily of international air cargo, almost all of which is bound for SFO. An obvious market is for "express" packages (i.e., FedEx and UPS) shipments between the Airport and downtown San Francisco, and Moffett Field. Under this scenario, the express company would set up distribution operations in a Port of San Francisco pier, and at Moffett Field, adjacent to the proposed hovercraft terminal, where they would sort packages and arrange for shipments between the Airport and the delivery addresses. Based on an analysis, however, most of those shipments use Oakland Airport.

The final market is for the transportation of "high-value" bank paper, mainly checks, which require quick transfer as part of the money transfer process. An earlier study for the Port of San Francisco estimated that about $ 2 billion worth of checks nightly, or about three tons of canceled checks nightly, are processed by San Francisco banks. Ferry service may be perceived as being more reliable than traditional trucking methods.

NEXT STEPS

This study finds that there is a market demand for amphibious ferry service between downtown San Francisco and San Francisco International Airport, and between Moffett Field and the Airport. The study also finds that the operation of both routes is financially feasible.

Hovercraft can operate on San Francisco Bay and to the shoreline of downtown San Francisco and to Moffett Field. Environmental issues should be addressed, but include impacts at Moffett Field and noise issues in downtown San Francisco. The largest operational issue is operating hovercraft across the airfield at the Airport. All of these issues can be tested, and appropriate mitigations tried, during the proposed demonstration of hovercraft technology scheduled for Summer, 1998 in San Francisco Bay.

To manage the demonstration, and should it be successful, the further advancement of the Airport Ferry Project, the Airport Commission should appoint a Project Manager, Airport Ferry Project. The Project Manager would be charged with managing the demonstration and documenting the results of the demonstration. Should the demonstration prove successful, the Project Manager would determine the level of private sector interest in the proposed service, and then solicit for, review and ultimately recommend awarding of a long-term franchise agreement to an appropriate maritime operator, subject to Airport Commission approval. The Project Manager would also be charged with developing an overall financing plan; a service plan; developing and managing an airfield safety plan, including access through the Coast Guard Base or through the Airport's ramp; reviewing and recommending for approval a terminal improvement concept; and managing whatever investment the Airport Commission makes in the project.

INTRODUCTION

"Build it and they will come" has become the cry for a vast number of speculative public works projects. Except at San Francisco International Airport.

"They" are already here. Passengers are literally flooding the Airport. Current Airport facilities, originally designed to process 27 million passengers a year, processed almost 41 million passengers in 1997, with about three quarters of those originating in the Bay Area. This huge growth has placed an enormous burden on the Airport's ground access modes. And it has lead to searches for other transit options to the Airport.

Can a waterborne transit system play a role? Four years ago, the Airport commissioned a study that suggested an amphibious ferry system, directly accessing the terminal buildings from the airside, could be commercially viable at some point in the future.

This study will determine whether that time is now. It will also investigate options other than amphibious vessels, and terminal locations other than downtown San Francisco, which were the limit of the earlier study effort. It is possible that a positive result from this study will lead to further analysis including detailed engineering and operational analysis.

STUDY OBJECTIVES

The objectives of the updated Airport Ferry Study are:

- Revisit and refine the previous Airport Ferry Study, and include additional technical information and recent developments.

- Expand the original study to include an analysis of five additional destinations and make preliminary judgments about the applicability of the waterborne mode to cargo shipments.

- Evaluate the possibility and effectiveness of a demonstration project in Summer 1998. Develop criteria for a demonstration project.

- Evaluate the feasibility of any waterborne plans submitted by private entrepreneurs.

PROPOSED FERRY SYSTEM OBJECTIVES

The objectives of any waterborne transit system into San Francisco International Airport would be to:

- Reduce airport related ground traffic.

- Develop a multi-modal access system to airport facilities.

- Work in cooperative and supportive efforts with existing established private transit operators.

- Design a system that requires a minimum of capital subsidy and no operational subsidy.

- Design a contingency access mode that could be used during earthquakes or at other times when landside civil structures are damaged.

EXECUTION OF THE STUDY

This study was developed by Pacific Transit Management Corporation, a Berkeley-based transportation consulting practice, in association with Ann Stevens Associates, which developed the patronage estimates, and Fox Associates, which was responsible for engineering and cost analysis.

In December, 1997, at about the one-third point of the study, the Airport Commission convened a "Peer Review" group to review the preliminary results of the study effort. This Peer Group consisted of the following individuals, all of whom have extensive maritime and/or transportation experience. These individuals included:

Raymond Deardorf
Planning Manager, Washington State Ferries
Seattle, Washington

Geoffrey Gosling
University of California, Berkeley
Berkeley, California

Stephen Phillips
Editor, Janes High Speed Marine Craft
Chichester, Sussex, United Kingdom

Joe Wyman
Former Port of San Francisco Planner
Oakland, California

C. Robert Ward
C. R. Ward & Associates, Ltd.
Marine Consultant
Sidney, British Columbia, Canada

Generally, the Peer Group's findings and suggestions fell into the following categories:

- The Peer Group thought that airport ferry service should be a private sector matter, with limited subsidies for capital and no subsidies for operations. The group thought that the Airport has a role in the development of facilities and terminals, however.

- Regarding patronage, the Peer Group suggested that there be some analysis on the effect of BART competition with the various ferry service proposals. In addition, the group suggested that the consultants develop a range of patronage for each route. The Peer panel also suggested that a rough estimation of employee travel demand met by the ferry should also be considered.

- On engineering matters, the group suggested that each individual hovercraft should not be operated for more than about 4,000 hours annually. In addition, the group suggested that the assumed capital cost for hovercraft be increased and the cost for catamarans be reduced.

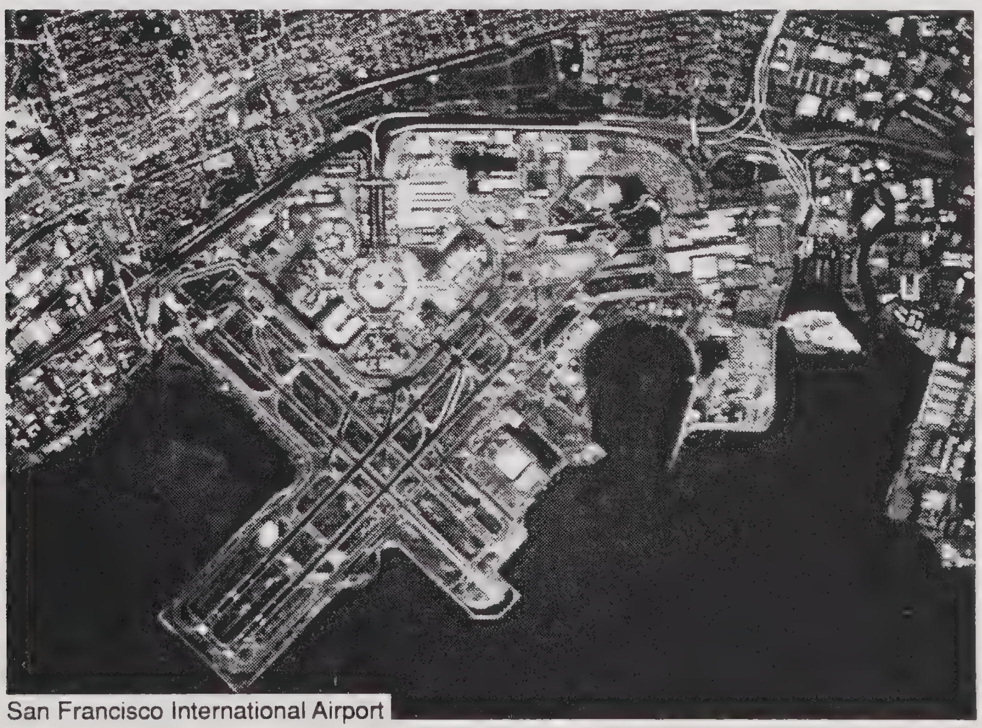
- Finally, the group suggested that any initial plan be phased in, and should probably start with the downtown San Francisco to SFO route, since this service would allow for transfers at the Ferry Building to the entire Bay Area ferry network.

Most of the suggestions of the Peer Review panel have been incorporated into this report.

TRAVEL AND TRAFFIC TO SFO — AN OVERVIEW OF AIRPORT GROWTH

San Francisco International Airport has grown significantly in the last five years. It is expected to continue growing for the next several years. As noted, in 1997 41 million passengers used the Airport — a number that was not expected for another two years. Based on the expected growth, by the year 2000 the Airport could process almost 45 million passengers — with 32 to 35 million originating in the Bay Area. [1]

Parking is at a premium, and the Airport facility, with limited amounts of land (only about 2,500 surface acres) cannot easily accommodate more automobile storage. Indeed, the Airport's resources, including its money and its property, are being channeled into higher priority projects. A new International Terminal, with 26 gates, is rising to accommodate increased trans-Pacific traffic. To cope with traffic increases the Airport has considered consolidating airport access services in a Ground Transportation Center, which would handle off-Airport ground transportation services including shuttles, taxis and door-to-door vans. In addition, a centralized rental car facility is now under construction at the north end of the Airport. The rental car facility would be linked to the terminals and other outlying Airport areas by the Airport Rail Transit System (ART). An ART station may be built at the Seaplane Harbor should non-amphibious water transit service be provided.



San Francisco International Airport

Clearly, automobile parking is getting harder to squeeze into the Airport's limited real estate. Remote auto parking sites adjacent to the Bay (as is the Airport) may be an option. Under such a scenario, these remote parking sites would be linked to the Airport via a boat instead of the more common shuttle bus. Under these conditions, ferry service may be financially viable.

THE FERRY VESSEL MARKET — WHAT'S AVAILABLE

WHERE FERRIES OPERATE AT U.S. AIRPORTS

San Francisco Bay airports are similar to several other airports around the world that are successfully served by ferries.[2] For example:

- Boston's Logan International Airport (1995 air traffic was about 24 million passengers) is connected to downtown by the Airport Water Shuttle, a privately operated service under agreement with the airport operator, the Massachusetts Port Authority. This service uses a conventional monohull and at the airport end requires a bus transfer to the airline terminals. Extremely poor traffic conditions make the ferry an attractive option, even with the transfer. About 150,000 annual passengers (400 to 500 per day) use the service. In addition, a new ferry service, linking Boston's South Shore with Logan recently began service. The Harbor Express operates from the Quincy Shipyard to Logan Airport about every 30 to 40 minutes. About 300 to 400 daily air passengers choose this service, which charges a fare of $10.[3]

- In New York City, Delta Airlines operates a ferry service between its Delta Shuttle terminal at La Guardia Airport and downtown Manhattan. Service is provided hourly, passengers walk from the Marine Air Terminal to the vessel (a conventional monohull), and no bus transfer is required. However, the service only operates weekdays, and takes up to 45 minutes. Patronage averages only about 125 passengers per day. The Port Authority of New York and New Jersey, the airport operator, has selected a new ferry operator to operate catamaran service from a dock adjacent to the US Airways and Delta (not the Shuttle) terminals to Manhattan. Passengers would be able to walk to this service from the US Airways and Delta terminals, but would require a bus shuttle from the Central Terminal. This new service would operate every 20 to 30 minutes weekdays, with several stops in midtown and downtown Manhattan. Sailing time to Wall Street is expected to be about 25 minutes, and the round trip fare is estimated at $25. The selected operator expects to carry between 1,000 and 1,200 passengers weekdays. La Guardia handled about 21 million passengers last year, or about 55,000 daily.[4]

- In Copenhagen, SAS operates a conventional vessel between the airport in Copenhagen and the city of Malmo, Sweden. (Copenhagen Airport processes about 15 million passengers annually). This catamaran service replaced a hovercraft service which operated the same route. It should be noted that the

hovercraft did not access the terminals and passengers were still required to transfer to a waiting bus.

- Brisbane, Australia experimented with hovercraft for a two year period. The service was privately operated and connected the airport with a land development project. Brisbane Airport processes about 10 million passengers annually.

ALTERNATIVE VESSELS — CRITERIA

Reliability and safety and the ability to meet state and federal statutory requirements are necessary in any ferry system. This study will follow the criteria outlined in the Metropolitan Transportation Commission's (MTC) 1992 Regional Ferry Plan.[5] (MTC is the State-created agency responsible for transportation planning and funding allocations in the nine Bay Area Counties). While other vessels may be available as designs or prototypes, the conservative approach used in the MTC study, where the analysis relied upon "off-the-shelf" technology, cannot be minimized. This approach directly lead to the purchase of four new Bay Area ferries (all based on existing and operational vessels), and their successful and uneventful implementation. The critical requirements are:

- Proven and Reliable Vessels - No hull design was recommended that had not been previously constructed and safely operated in the speed and load conditions applied to the considered routes.

- Flexible Interior Arrangements - No vessel was recommended unless the vessel designer/manufacturer could accommodate special boarding and debarking arrangements, cargo and baggage stowage, conformance with the Americans with Disabilities Act, etc.

- American Built - No vessel was recommended unless it could be manufactured in the United States. Most of the acceptable vessels are of foreign design and are mainly manufactured abroad, but U.S. law (46 United States Code) requires that vessels operating between U.S. ports be built in American shipyards. Therefore, foreign designers must have arrangements to license their technology to an American affiliate.

With these guidelines in place, only a few vessels met both the MTC study's passenger capacity and speed requirements. Several technology options were reviewed including:

- Hydrofoils would not be suitable for Bay Area use, owing to their deep draft requirements and their susceptibility to disablement from submerged flotsam. The result of an impact would usually be a costly and time consuming drydocking.

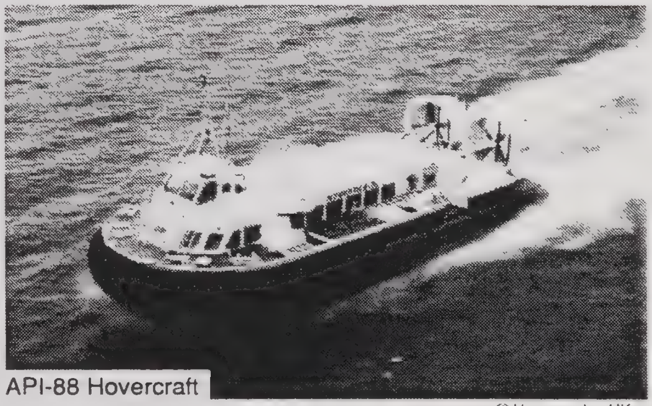
- Catamarans: In the past 20 years, the catamaran design has steadily eclipsed other hull forms as the choice of most ferry operators for passenger only operation. The catamaran offers: a more stable platform than the monohull, excellent maneuverability (owing to widely spaced propellers), "wide body" passenger spaces where more arrangement options are possible, low draft requirements at a given hull displacement, and reasonable economy of operation. However, compared to monohulls of similar size, capital costs are higher and

wider vessel berths are required. At low speeds, operating inefficiency increases, which also increases fuel consumption and fuel costs. Waterjet propulsion catamarans were recommended in the Regional Ferry Plan for most Bay Area ferryboat services because above 25 knots waterjets are more efficient and provide better maneuverability. Four of these vessels have been purchased — two Advanced Multi-Hull Design (AMD) catamarans for Vallejo, one AMD catamaran for Golden Gate Ferry (under construction), and an InCat catamaran for the Oakland-Alameda ferry. All the vessels have proven reliable and efficient.

- Conventional Monohull designs are still most commonly used in the U.S., especially where speeds over thirty knots in high sea conditions aren't required. The semi-planing monohull represents the low capital cost, low maintenance option for relatively protected waters.

- Surface Effect Ships are modified catamarans which employ lift fans to raise some, but not all, of the hull, out of the water, thereby decreasing hull resistance. SES vessels can operate with low fuel usage and high speeds but have high capital cost/seat, high-weight sensitivity, high maintenance requirements and costs, susceptibility to speed loss in heavy sea conditions, and a less comfortable ride.

- Hovercraft: While Surface Effect Ships are propelled through the water (~85 percent of the hull weight is lifted out of the water), hovercraft travel totally above water and are propelled through the air. This hull form is attractive for certain shallow areas of the Bay (since the vessel travels above the water and not through it) and is faster than other vessels (since it has little contact with, and hence little friction from, the surface water). Since these vessels are amphibious they can operate across land to a terminal distant from the Bay. Downsides include high capital and maintenance costs, somewhat bumpy rides, and, most importantly, high levels of exterior noise. Designers are making improvements to lower the sound thresholds and have experienced some success.


API-88 Hovercraft
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The Regional Ferry Plan did not recommend hovercraft for use on any conventional route, primarily because catamaran technology exhibits superior ride quality at lower capital and operating costs. However, a hovercraft's amphibious abilities are clearly an advantage in airport access uses. The Regional Ferry Plan's estimate of patronage (to airports) decreased by two-thirds when passengers were required to transfer to another vehicle at the water's edge. We should note, however, that no commercial hovercraft are operating in American waters today.

The water-transit enthusiast should also consider the following cautionary tale of working with non-conventional vessels. In 1994, the City of Alameda received $1.8 million from

the California Transportation Commission to purchase an additional ferry for the Harbor Bay to San Francisco route. Alameda, along with its operator Harbor Bay Maritime, opted to invest the public funds in an untested vessel. This boat, built in Florida, is a catamaran hull with an underwater foil that provides lift. It is essentially a hybrid between a hydrofoil and a catamaran. The concept was proven technology but the design was not adequately analyzed and tested prior to construction, and as a result the vessel failed in several areas. During a very short trial period, it broke a power shaft, had several engine cooling problems, and most importantly, had poor speed control, especially between 20 and 30 knots. The experience and the vessel were so unreliable that the vessel was docked and lengthly litigation has ensued.

MARKET ANALYSIS

THE HOME TO SFO MARKET — WHO MAY RIDE

From a planning and marketing perspective, ferry service is essentially a non-stop trunk service linking two points with a high capacity transportation system. In many ways, ferries are simply waterborne railroads, with terminals at either end capable of processing thousands of passengers daily. With this ability to process large numbers of customers also comes increased costs associated with higher capacity systems.

Generally, a high capacity (300+ passengers), high speed (34+ knots) vessel has a capital cost of about $8 - $10 million. It has a useful life of about 30 years, given a midlife technology upgrade. The life cycle cost of a ferry is usually lower than comparable bus service (when factoring in vehicle/vessel life, operating cost per seat mile, and right-of-way costs) in corridors that have enough ridership (generally seat occupancy of about 50 percent, combined with attractive service frequencies, although formulas vary) to justify the higher costs of higher capacity modes.

Obviously, in the Airport setting, it is not possible to operate ferries from everywhere to the Airport. Only a limited number of routes have sufficient patronage density to justify Airport ferry service.

MTC's 1995 survey[6] of SFO passengers indicates high passenger concentrations near possible ferry terminal sites:

TABLE 3
ESTIMATED 1995 DAILY
SFO AIR PASSENGERS

Area	Enplaned and Deplaned
Downtown San Francisco	21,000
Marin	5,000
Vallejo	2,500
Berkeley	4,000
Moffett Field	7,500

In addition, private operators have indicated interest in several terminal locations, including Port Sonoma.

Consistent with the study's objectives, these five areas were studied, along with Port Sonoma. An analysis of demand for ferry transport to SFO was performed. Multinomial logit choice modeling techniques were used, adapting model specifications developed for airport access in the Bay Area in the absence of ferry transport. Travel time, wait time, and cost estimates of conventional and amphibious ferries from each candidate site to SFO, and times and costs of competing modes were all included. *Working Paper Number 3 provides a complete overview of the modeling process.*

AIRPORT FERRY SERVICE PATRONAGE — THE MODELING EFFORT

The model used to produce the ridership estimates presented in this report is a set of multinomial logit choice models published by Harvey in 1986[7]. Harvey developed separate models of airport access mode choice for Bay Area residents traveling for business and non-business travel, based on data from the Bay Area Airport Passenger Survey (APS) collected by the Metropolitan Transportation Commission in 1980. The APS data was cleaned and subjected to quality checks by Harvey, resulting in models with reasonable specifications and coefficient values, and good statistical performance. The quality and availability of the Harvey model, and the lack of alternatives appropriate to the level of resources available to the study, were the principal reasons for choosing the Harvey model. Because, however, the airport mode choice market in the Bay Area has changed significantly since the development of the Harvey model, legitimate concerns can be raised about the model's ability to replicate present-day travel patterns. These limitations predicated use of the Harvey models as exploratory tools used to bound ridership estimates, rather than to produce point estimates. Available models and recent changes in airport mode choice are discussed in more detail in the section of this report titled "Changes in the Airport Access Market".

MODEL STRUCTURE

Both the business and non-business sub-models model the choice among five basic modes of access to the airport. These modes, as defined in the Harvey paper, are:

> Drive: The traveling party drives a private vehicle to the airport and leaves it parked in the airport garage, or a lot, for the duration of the trip. Rental cars returned at or near the airport are included in this category, but not distinguished separately.
>
> Dropoff: The air passenger is driven to the airport by a friend, associate, or family member, who leaves the airport with the car. The air passenger may be dropped off at curbside or the party may park in the short-term garage.
>
> Airporter: The air passenger rides a scheduled, dedicated service to the airport. On-Call van services are included in this category.
>
> Transit: The air passenger rides scheduled, conventional public transportation to the airport.
>
> Taxi: The air passenger rides a taxi or similar personalized service to the airport.

The basic structure of the modal utility equations for the business and non-business sub-models is illustrated by the utility equation for the transit mode for business travelers:

$$U[Tr] = b_3 + b_5 * TT[Tr] + b_6 * AACC[Tr] + b_7 * Cst[Tr] + b_9 * Lug[TR]$$

Working Paper 3 presents a detailed overview and description of the modelling process, including the coefficients uses, and is included in this report by reference.

CHANGES IN THE AIRPORT ACCESS MARKET

The Harvey model used to estimate passenger demand in this study was developed more than 12 years ago. In the interim, pricing and availability of modes to Bay Area airports have changed, the most significant of these changes being the proliferation of On-Call van services and their capture of a significant market share.

At the time the Harvey model was developed the Airporter mode held a share of less than ten percent to Bay Area airports, and On-Call vans did not hold a significant enough share to be modeled as a separate mode. Tabulation of the 1995 Air Passenger Survey suggests that the combined share of Airporter and On-Call modes is on the order of 20 percent. Alternatives to the Harvey model that would include On-Call van and be based on more recent data were sought. Use of Harvey's ACCESS software, a model of airport and mode-to-airport choice, was considered, because ACCESS was developed later and included On-Call as a mode. However, ACCESS was not available to the study in digital version, and the effort to implement the published printed code was well beyond the resources of this study. Furthermore, there was a great advantage in using the Harvey model. Harvey spent many hours cleaning the Air Passenger Survey data, resulting in a dataset in which he had a high degree of confidence, and in a model with good statistical and intuitive performance.

The quality of the Harvey model and the lack of alternatives dictated its use for this study. The model was adapted to include the On-Call mode by modeling it with the same coefficients as the Airporter mode. Even so, the base case, without-ferry model run produced a mode share for Airporter and On-Call that was well below the share represented in the 1995 APS survey — it is therefore a conservative estimate of the potential for any "shared-ride service," including an airport ferry service.

It was recognized that adapting the 1985 Harvey model to include modes not in the original specification reduces the confidence in the estimates provided by the model compared to estimates that would be provided by a model specified to include all modes and fit on current data. It was therefore decided to use the adapted model to bound estimates of demand for the ferry mode by modeling it with different sets of coefficients, rather than to rely on point-estimates. It was also decided to be as conservative as possible in interpreting demand estimates from the model. One source of conservatism built into the analysis is the fact that only demand by residents is modeled – any travel by visitors to the Bay Area on ferries will be in addition to demand estimated in this study.

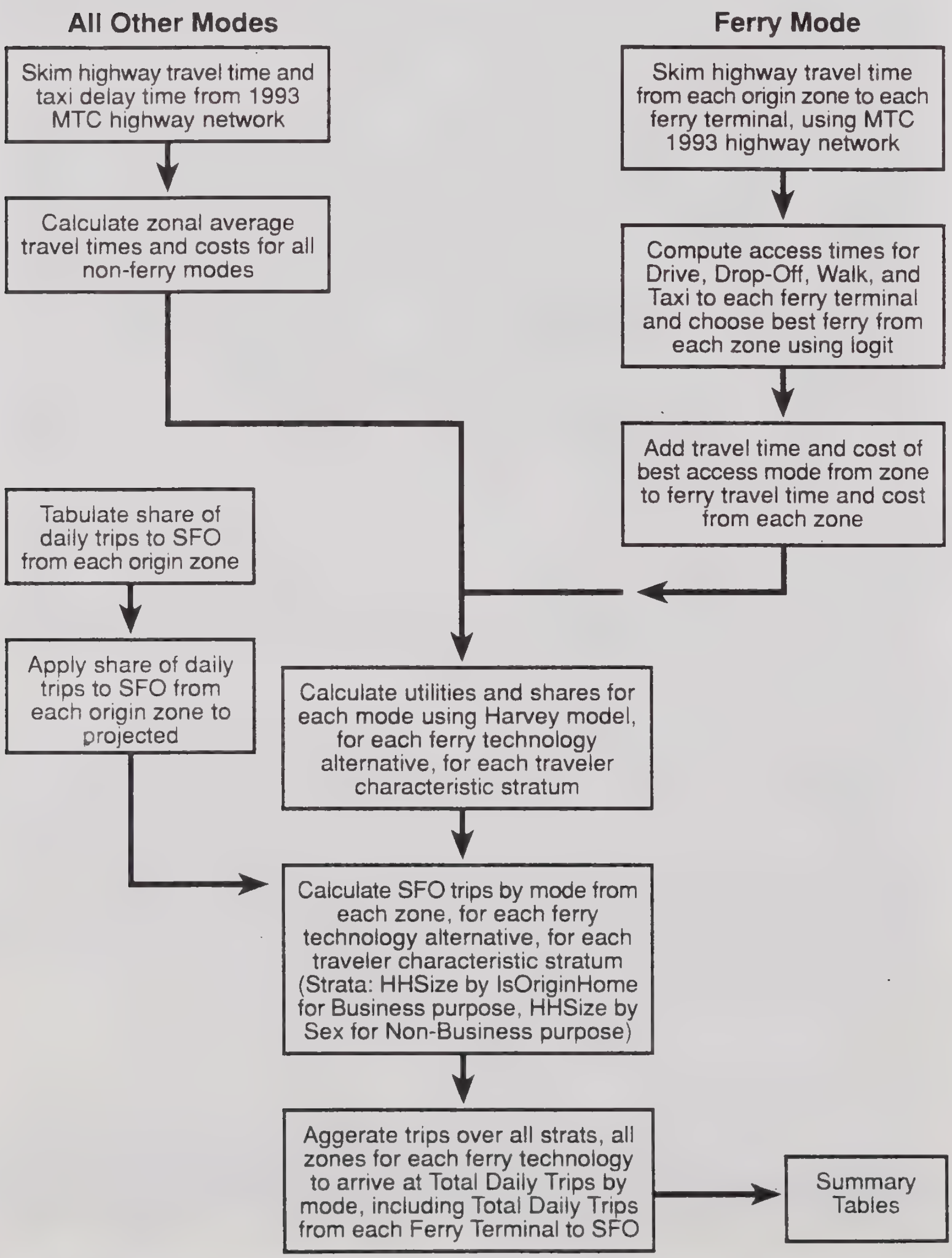
APPLICATION OF THE MODEL

Harvey's mutlinomial logit model was applied to estimate ridership for six candidate ferry terminal sites, for three technology alternatives. The basic methodology, illustrated in Figure 1, was to develop travel times and costs for the ferry mode and for each competing mode, adapt the Harvey model to produce two sets of estimates of mode shares from the

six locations for each traveler stratum, and finally to apply the shares to projected total trips for each stratum to arrive at total SFO trips by mode.

Resources available for the patronage analysis dictated an aggregated modeling approach. Zonal aggregate data describing travel times and costs of each competing ground access mode to SFO were developed for each of 1099 Bay Area Traffic Analysis zones, comprising the nine counties in the region. The zone structure used was chosen to be compatible with the MTC 1993 Highway Network

FIGURE 1
MODELING METHODOLOGY



The Harvey model produces utility and mode share estimates for 4 traveler strata for each of the Business and Non-Business sub-models. The Business sub-model requires stratification by Household Size (one and more than one), and by Trip Origin (Home or Not Home); the Non-Business by Household Size and by Sex. Utilities and shares were calculated for each mode, assuming that all other model parameters were independent of these strata – for example that distances to SFO or to Ferry or Airporter terminals would be the same for all households in a zone. This is almost certainly not the case, but of negligible consequence compared to the relatively large line haul distance to SFO.

Shares of trips to SFO for each stratum were obtained from the MTC 1995 Air Passenger Survey by tabulating APS responses by residency (Bay Area or not), by purpose (business or non), by household size, trip origin, and sex. The APS data was used without cleaning, with the exception that non-responsive records and records coded as "Other" for the household size, sex, mode to airport , or luggage questions were omitted. Shares of all trips to SFO were then applied to projected enplanements and deplanements attributable to Bay Area residents, resulting in an estimate of daily one way trips for each mode, for each socio-economic stratum. It is assumed that the directional mode split will be equal – that approximately the same number of trips will be made on each mode from the airport as traveling to it.

The derivation of projected total Daily and Annual trips by residents and non-residents to and from SFO is as follows. By year 2000, there will be about 45 million enplanements and deplanements (not connections) at SFO, 80% of which are domestic travel. From the MTC 1995 APS,

40% of enplanements and deplanements are by residents	= 14 million/year
60% of enplanements and deplanements are by visitors	= 20 million/year
36 % of residents are traveling on business	= 5 million trips/year
64 % of residents are not traveling on business	= 9 million trips/year
resident business: 5 million trips/year @ 300 days/year	= 16,667 trips/day
resident non bus: 9 million trips/year @ 300 days/year	= 30,000 trips/day.

The above values, 16,667 trips per day for resident business travelers, and 30,000 trips per day for non-business, were the base values to which the mode shares from the Harvey model were applied. These values do not include any trips by visitors, and are therefore a conservative basis on which to estimate airport ferry patronage.

Developing travel times and costs for the ferry mode required first developing a sub-model of access to ferry, in order to determine which ferry terminal travelers from each zone would use. The access model used coefficients from the Harvey model and included Drive Alone to all terminals except the Ferry Building (which will have no parking), Drop-Off, Taxi, and Walk.

Ferry wait travel time, wait time, and transfer time at SFO are products of the marine engineering analysis completed for this project. The technology alternatives modeled are conventional ferry at 30 knots, and shallow-draft hovercraft ferry at 40 and 45 knots. Conventional ferry would require a bus transfer to the terminal at SFO, with the total ferry-to-terminal time estimated at 12 minutes. Hovercraft ferry would leave the Bay and proceed under its own power (or that of a tug) to SFO, so that passengers would disembark in the

terminal without changing modes. The time required to traverse the runway and apron areas is estimated to be 3 minutes.

Travel times and fares are shown on pages 22-23 and 27-28 for six candidate ferry routes:

- Ferry Building in downtown San Francisco, which would have no parking,
- Berkeley/Albany near the Golden Gate Fields race track,
- Moffett Field in Santa Clara county,
- a site adjacent to or near the existing Larkspur Ferry Terminal in Marin County,
- the Port Sonoma waterfront in Sonoma County, and
- a site near the existing Vallejo Ferry Terminal, on the Cal Maritime Academy campus.

The fare to ride the ferry was modeled as $10 from the Ferry Building and Moffett terminals, the closest of the six sites, $12 from Berkeley and Marin, and $15 for the much longer Port Sonoma and Vallejo runs. Parking at all sites was assumed to be $8, and as specified by Harvey half of the daily parking charge was attributed to the each direction of the trip. Two days of parking were assumed for this analysis for ferry and for drive alone to SFO, based on the median value from the 1995 APS data.

Public Transportation to SFO was not modeled in the initial analysis. The 1995 APS Survey found that less than 2% of trips to SFO were on public transportation, and as discussed in an earlier section there is reason to suspect that even this value is high. The patronage analysis is highly approximate, especially given the need to adapt the Harvey model to include modes not originally specified. The analysis is not precise to 2% of the total trips to SFO, and the resources to model transit would have been substantial, therefore it was decided that the mode could be omitted with little impact on the outcome.

The initial analysis did not include BART as an access mode to SFO, because initial interest was in Ferry as a mode to be made available well before the BART extension to SFO will be completed. After the initial analysis suggested that some sites locations are candidates for viable ferry operations, interest in how Ferry and BART might affect one another grew. An analysis of travel times and fares in the portions of the SFO travel market where Ferry and BART will overlap was conducted and is presented in Table 4 on page 13. Several important observations can be made from the table. First, it is apparent that there is a great deal of difference in the lower and upper higher ridership estimates. If travelers perceive Ferry as a mode similar to Airporter, the ridership from each terminal will be about two to four times the ridership if travelers were to perceive the mode as like Public Transportation. This is a wide range. This range can be explained in a number of ways, but the quality of the ride, the reliability, and the ease of the trips are all factors. Public transit services are perceived as low quality and slow, and often times requiring excessive bag handling and changes in vehicles (transfers). Should a ferry service exhibit any or all of these qualities, then patronage would be lower. It is likely that a conventional craft, requiring a transfer to a bus, would be perceived closer to "public transit" than to "airporter."

Second, reducing the headway from 30 to 20 minutes has a relatively small effect on ridership at any terminal. The headway decrease would increase ridership between about 15 and 20 percent of the 30 minute headway ridership levels, depending on location.

Third and most important, there is great variation between ridership levels at the six terminals. The Ferry Building ridership is 4 to 5 times the ridership of the site with the next highest ridership, for any headway and technology combination, regardless whether

transit or airporter coefficients are used. If travelers behave as though Ferry is like transit, the ridership from the Ferry Building will be about 1000-1600 riders, depending on the technology and speed of the ferry. If, as is more likely, travelers act as though Ferry is more like Airporter, ridership would be in the range of 2300 to 3800 per day from the Ferry Building. Ridership would increase dramatically with the higher speed hovercraft ferry, if riders treat the ferry mode like Airporter.

Except for the slowest technology, the terminal with the next highest ridership is Moffett Field. As shown in Table 4, ridership with transit coefficients would be in the range of 200-400. With Airporter coefficients, the range would be about 600 to 1200. The increase in the higher estimates of ridership between the conventional ferry and the hovercraft is greater here than for the Ferry Building – ridership would nearly double with the improved technology. This is in part because the distance is greater from Moffett to SFO.

TABLE 4
AIRPORT FERRY PATRONAGE PROJECTIONS

Terminal	Service Type	Service Frequency	Transit Output	"Airporter" Output	Estimated Patronage
San Francisco	Conventional	20 min	1169	2699	1754
	Conventional	30 min	974	2273	1461
	Amphibious	20 min	1605	3870	3675
	Amphibious	30 min	1327	3605	3424
Moffett Field	Conventional	20 min	248	752	371
	Conventional	30 min	203	635	305
	Amphibious	20 min	399	1280	1200
	Amphibious	30 min	332	1224	1163
Marin	Conventional	20 min	234	340	351
	Conventional	30 min	223	309	334
	Amphibious	20 min	269	508	482
	Amphibious	30 min	252	498	473
Berkeley	Conventional	20 min	111	334	167
	Conventional	30 min	92	270	137
	Amphibious	20 min	160	609	579
	Amphibious	30 min	131	576	547
Port Sonoma	Conventional	20 min	58	228	87
	Conventional	30 min	47	180	71
	Amphibious	20 min	98	617	586
	Amphibious	30 min	122	606	576
Vallejo	Conventional	20 min	56	200	84
	Conventional	30 min	46	159	69
	Amphibious	20 min	107	568	539
	Amphibious	30 min	123	561	533

Note on table: Final patronage is assumed to be about 150 percent of forecast using the "transit" mode for conventional vessels and about 95 percent of forecast using the "airporter" mode for amphibious vessels. This is based on the transfer required at waterside under the conventional scenario, and under the amphibious operation allows for some uncertainity.

The estimated ridership from the remaining sites is, in general, much lower. Marin would attract between 200 and 300 riders at the lower bound, and 300-500 for the higher estimate. The remaining sites would attract 100 or fewer riders to 200 at the lower end, and 200 to 600 at the upper level.

The ridership estimates in Table 4, interpreted in light of the estimated operating costs of the six terminals, strongly suggest that the candidate sites for the first phase of Ferry operations should be the Ferry Building and Moffett Field. The remaining sites have lower ridership estimates and higher operating costs, due to longer distances, rougher seas, and more constrained terminal sites. It may be that operations at these locations could be viable, depending on how travelers perceive the mode ferry mode from the first phase of operations.

EFFECT OF A LOWER PARKING PRICE AT THE MOFFETT TERMINAL

An additional set of model runs was completed to test the idea of a lower parking fee at Moffett Field. The parking fee for the new scenario was $4, compared to $8. No other parameters were changed. (The other terminal suggested for phase 1 operations, the Ferry Building, does not have parking.) The result is shown in Table 5.

TABLE 5
AIRPORT FERRY PATRONAGE PROJECTIONS

	$8 / day	$4 / day	% Increase
Conventional	752	1035	38%
Amphibious	1280	1712	34%

The parking fee change, which would reduce the cost of riding the ferry from $36 for two days to $28, would produce a ridership increase of between 30 and 40%. It would appear that the incremental difference in price would be more than compensated by an increase in passenger fares for the Moffett Field ferry.

BART AND THE FERRY

The Ferry Building is clearly the most viable candidate Ferry terminal site. Although the ferry operations are planned to start in the near-term, well before the BART connection to the airport is completed, there is interest in how the two modes will compete.

An analysis of travel times by Ferry from the Ferry Building and by BART connecting to the planned airport people-mover was prepared, for zones in San Francisco and in San Mateo county north of the airport. The result of the analysis suggests that the ferry will be significantly faster from zones in and near downtown San Francisco, the time difference will be on the order of 15 minutes. For zones outside downtown, especially to the most western and southern zones, BART is the faster mode.

The value of time for business travelers to SFO found by Harvey in 1985 was approximately $42, indicating that a 15 minute time savings would be valued at more than $10. Thus, although the ferry would be more expensive from downtown San Francisco than BART, business travelers would be likely to spend the additional amount for the speed (and greater

convenience) of the ferry. Non-business travelers have a lower value of time – perhaps half that of business travelers. But even at a value of time of $5 per hour, non-business travelers would still be expected to use the ferry from the downtown area.

Ferry ridership from the Ferry Building terminal is predicted to come disproportionately from the zones concentrated in and near downtown San Francisco. The ferry will be faster from these zones than BART. It appears unlikely, then, that the completion of BART to the airport will significantly decrease ferry ridership from the Ferry Building, if travel times and costs are near the estimates used in this analysis. If the choice is between BART and the ferry, BART will be the mode of choice from western and southern zones in San Francisco, as well as in the East Bay. In these areas, BART will be both faster and less expensive than the ferry.

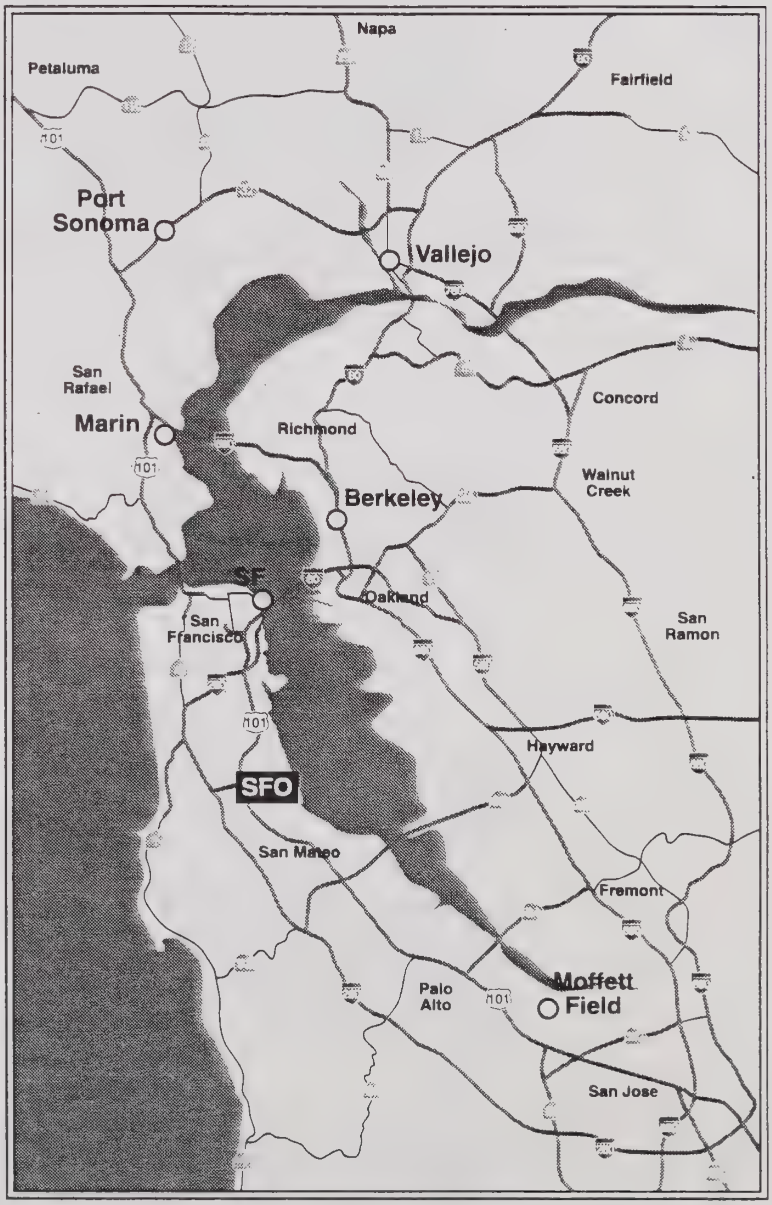
ENGINEERING ANALYSIS

The Engineering Analysis for this study originally investigated three different craft and estimated the travel time and operating cost for each vessel type. The three vessels were a conventional catamaran, a hovercraft and a new vessel type, a quadmaran. During the Peer Review process, the Peer panel recommended that the quadmaran be dropped from consideration. The panel concluded the vessel is not proven technology. This analysis therefore deals with catamaran and amphibious hull types.

THE MARINE ENVIRONMENT

Each of the studied vessel types must operate in the San Francisco Bay maritime environment. Generally, San Francisco Bay may be characterized by two separate waterbodies (North, or San Pablo Bay, and South, or San Francisco Bay) with a transition set between them.

To the north, the Pinole Shoal Channel, in San Pablo Bay, is maintained at a depth of 33 feet, deep enough for nearly all vessels. This channel extends as far northeast as Vallejo and the Carquinez Strait. West and South of the channel, the Bay shoals rapidly to depths of seven feet and then less as the coast is approached, making navigation by conventional craft unsuitable outside of three dredged channels; one to Larkspur, a second to San Rafael, and the third to the mouth of the Petaluma River. These channels are dredged up to a maximum of seven and a half feet and are suitable for small shallow draft vessels. San Pablo Bay is well protected from extreme ocean weather and typically experiences choppy wind driven seas with a short fetch, rising to less than three feet.



San Francisco Bay
Dark shading represents portions of bay deeper than 6 feet

The center transition is the area where San Pablo Bay meets with San Francisco Bay and adjoins the waters of the Golden Gate. Waters here are affected by long wave length ocean swells coming through the Golden Gate; these diminish as they move across the Bay, but can affect the East Bay between Richmond and Oakland.

San Francisco Bay, that portion roughly south of Treasure Island, is deep enough in the center basin for large vessels, but the shore lines on both sides shoal rapidly to unnavigable depth, except through narrow channels dredged to seven and a half feet to South San Francisco, San Francisco International Airport (SFO) and Redwood City. Weather in this area is similar to San Pablo Bay in intensity but more subject to shifting winds from onshore sources. Currents are more pronounced and may reach two and a half knots at maximum flood.

SPECIFIC CRAFT STUDIED

This report deals with these hull types:

- Amphibious — As noted, an amphibious vessel may be of great advantage in an airport setting, since it would eliminate a passenger transfer to access the terminals.

- Conventional — The new Bay Area catamarans have successfully transitioned from exotic design to proven technology and will be the work-horses of the Bay Area ferry fleet.

These technologies all offer distinct advantages and disadvantages. However, each of these vessels will be judged against established environmental and cost criteria.

CRITERIA FOR VESSEL TECHNOLOGY ANALYSIS

ENVIRONMENTAL CONSIDERATIONS

Environmental considerations in all forms of water transportation typically involve air pollution, noise pollution, wake wash effects, and shoreline land use issues.

Air pollution: All forms of water transportation considered involve diesel engine propelled craft and all diesel engines have a signature for NOX pollution which must be addressed. Generally speaking, the quantitative NOX pollution per passenger mile carried in high speed marine craft will be comparable with that produced by buses or diesel vans and the CO and CO_2 signatures will be considerably less than those produced by private gasoline powered vehicles. Regardless of the comparison between different modes, water transportation services must meet California's strict air quality standards. Past studies in connection with other water transportation systems (Vallejo and Alameda, for example) indicate that this is not an obstacle to implementing a transportation system.

A Satisfactory Waterborne Operation will meet all California emission requirements.

Noise pollution: Noise is measured in decibels, a logarithmic scale which begins at 0 (the threshold heard by the human ear) and raises above 100 to a level that causes injury. Noise is generated at discreet frequencies but this discussion deals only with the broad spectrum

of human hearing. Within a passenger cabin, noise levels of ~70-73 dB are normal and these are levels at which people can converse across a few feet without shouting. Noise decreases as the square of the distance from the source and external noise must be measured in relationship to the distance from the source. California law (Vehicle Code Section 27204) requires that motor vehicles not exceed 80dB 50 feet (about 15 meters) from the noise source. The most reasonable and consistent criteria would require vessel operations to generate no more than 80 dB for monitoring device located within 15 meters from shore.

A Satisfactory Waterborne Operation will not exceed noise levels of 80 dB within 15 meters from shore.

Wake Wash: The U.S. Coast Guard establishes speed limits in heavy traffic areas on a number of criteria, including wake wash as it affects both other vessels and shoreline property. Some vessels, the Vallejo ferries M.V. Intintoli and M.V. Mare Island for example, have been designed specifically for a low wash signature.

A Satisfactory Waterborne Operation will not cause excessive wake wash.

Shoreline Land Use Implications: The construction of new terminals in areas that are wetland protected (Moffett Field, and Port Sonoma for example) may trigger extensive studies dealing with the impacts of vessel operation in sensitive shoreline locations. Even terminals in less sensitive locations will require permits from various regulatory authorities; obtaining these permits may require environmental mitigation.

A Satisfactory Waterborne Operation will conform to local and regional land use plans and will either cause little environmental impacts, or will mitigate those impacts.

RELIABILITY AND OPERATIONAL CONSIDERATIONS

Safety: Safety is the paramount issue concerning the operation of any transportation service. Safety includes many factors such as fire protection, ship control sensitivity, stability, ability to sustain damage without catastrophic failure.

A Satisfactory Waterborne Operation will operate in a safe manner.

Reliability: Next to Safety, reliability is the most important consideration of any scheduled transportation service. The selected vessel must have the ability to consistently and predictably operate and meet an established schedule, demonstrated by past service.

A Satisfactory Waterborne Operation will operate reliably.

Comfort: Passenger comfort, in both interior finishes and in ride and operation, should provide the highest passenger comfort. The quality of ride ensures that people come back next time.

A Satisfactory Waterborne Operation will provide high passenger comfort.

COST CONSIDERATIONS

Operating Cost: A transportation service should provide an efficient and cost-effective operation. Efficiency of operation is often expressed in terms of the cost of operation per passenger mile.

A Satisfactory Waterborne Operation be cost-effective enough to attract the interest of private sector financing, sponsorship and operation.

TECHNOLOGY REVIEW

TERMINOLOGY

Terminology: All vessels that operate on the principal of reducing water resistance by raising the vessel partially or completely out of the water are called *Dynamically Supported Vehicles* (DSVs). The generic name for vessels which are supported on a cushion of air in/over the water is *Air Cushion Vehicles* (ACVs). Within the category of ACVs there are *Surface Effect Ships* (SESs) which usually support about 85% of their weight on an air cushion but are propelled underwater by propellers or waterjets. Vessels completely supported by an air cushion and able to move above the surface of the water and also over relatively smooth landside terrain are called *Hovercraft* (HOVs).

REASONABLE SPEEDS

Operational speed, the transit speed that is used for scheduling purposes, must be established on the basis of a dependable and safe speed in most weather and traffic conditions. The U.S. Coast Guard Traffic Control Office in San Francisco has, from time to time, discussed possible speed limits in the Bay but as of this writing, requires only that the speed of vessels be consistent with safe navigation. Given the frequent fogs in the Bay and unpredictable marine traffic, particularly north of The Bay Bridge to Alcatraz Island, speeds of more than 35 knots are considered unrealistic for scheduling purposes, although they may be possible from time to time in short spurts to make up scheduling losses. For the purposes of this study a range of possible speeds will be used as follows:

- Routes south of the Bay Bridge (Ferry Terminal to SFO): maximum of 40 knots, but no greater than vessel maximum operating speed.
- Routes north of the Bay Bridge: maximum of 35 knots, but no greater than vessel maximum operating speed.
- For the candidate catamaran, the 32 knot speed will be used for all studied routes.

HOVERCRAFT TECHNOLOGY

Hovercraft History: The concept of amphibious air cushion vehicles is not new. British Hovercraft Corporation (BAH) built the world's first amphibious hovercraft (air cushion vehicle) in 1959. The first noteworthy commercial application took place in 1962 when Westland HOVs first started operating a commercial service. Hovercraft have since performed some noteworthy services around the world and have gained a reputation as

reliable workhorses, not unlike helicopters, for specific applications where their amphibious quality makes them ideal for access to shallow, marshy, remote, ice bound, debris laden waters, while being able to come ashore safely in remote areas. Some notable applications in the last thirty years include:

- At Expo '67 in Montreal, two HOVs carried 110,000 passengers across the St. Lawrence River. In one day, two Westland SRN6s carried 4,072 passengers.

- SRN4s have provided service across the English Channel for more than 15 years, carrying passengers and vehicles.

- AP1-88s have provided service from Copenhagen to Malmo, Sweden as a regular portion of SAS scheduled service.

- AP1-88s have provided service at Brisbane Airport in South Australia.

Hovercraft Builders: There are several designers and manufactures of hovercraft, and this study considered several designs. Among the designs reviewed were modified U.S. military hovercraft designs, design/build projects using existing technology, and importation of some ex-USSR hovercraft design technology. Early on, the AP1-88 basic design emerged as the front runner for the following reasons:

- The basic AP1-88 design is the most tried and proven of all hovercrafts in service today. It has been used by other countries (including the U.S.) as a basic model for special developments.

- In the size range of interest (100-150 passengers) it is the most produced. The Griffons, for example, are too small and the LCAC designs are too large and too expensive.

- Westland has done more to develop an environmentally friendly vessel than other companies, particularly on the all-important noise issue.

- AP1-88 can be built relatively inexpensively because the design has been refined for ease of construction.

- The AP1-88 is a flexible design, lending itself to modification for special applications such as passengers with extra baggage and possibly small freight.

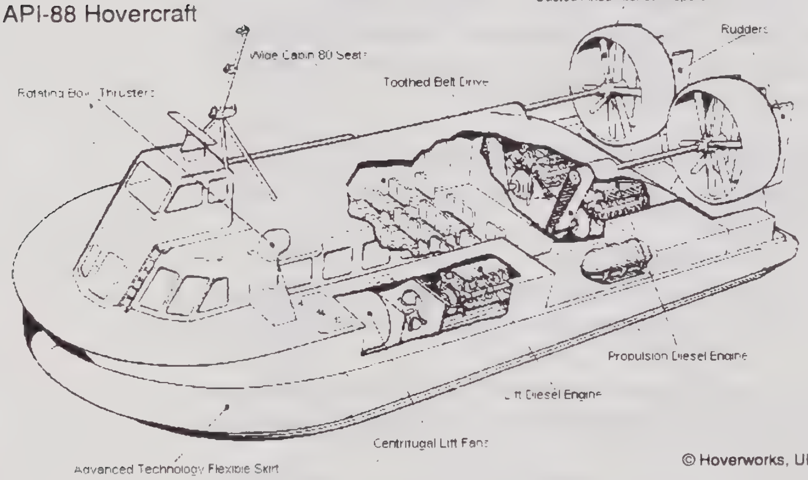
- AP1-88 has in fact served in identical roles in two other airports; one in Denmark and one in Australia.

- There are more AP1-88s in service with more operating hours than any other hovercraft designs. The few in-service failures have been almost entirely engine failures and the substitution of the Caterpillar 3400 series engines for the Deutz engines is considered to be a major step forward, as is the use of controllable pitch propellers.

Westland AP1-88: The AP1-88 was designed to meet the need for a medium sized relatively simple amphibious hovercraft which can be built and operated relatively inexpensively. Lightweight diesel engines were employed for propulsion. Great efforts were taken in the early models to reduce weight and airborne noise, and to increase the reliability and ease of replacement of the skirt materials. Much of the structure in the AP1-88 was developed from aircraft design, using lightweight all welded aluminum. The skirts were manufactured in "fingers", allowing easy replacement of the high wear sections when required.

The vessel was designed with three landing pads enabling it to rest steadily on almost any landing site, whether flat or not. The original AP1-88s were built with Deutz air cooled engines because of their comparatively light weight and low cost, and most AP1-88s operating in the world today have these engines. In recent years, other engine manufacturers have matched Deutz in weight to horsepower ratios and there are many more options today. The AP1-88-400s (referred to as Dash 400s) being built in Canada are in fact being fitted with Caterpillar 3400 series engines which have a better reliability record than the Deutz engines and are much better supported with service and parts in the United States. These vessels can operate in 35 knot winds (gusting to 40 knots) and in seas with 1.5m. significant waves (equivalent to 2.4 m. maximum).

API-88 Hovercraft



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The Westland AP1-88 400: The AP1-88 400 version is a development of the earlier versions which is best illustrated by the comparison table shown below:

Characteristic	**AP1-88**	**AP1-88-400**
Overall length	24.2 m (80.5 ft)	28.5 m (94 ft)
Overall beam	11.5 m (37.9 ft)	12.0 m (39.5 ft)
Well deck length		15.5 m (50.85 ft)
Well deck width		4.6 m (15 ft)
Max Operating Weight		70,000 kg (77.17 tons)
Max Disposable Load		23,000 kg (25.36 tons)
Maximum Speed		50 knots (62.5 mph)
Engines	4 Deut. 12L513	4 CAT 3412
Total Power	2072 hp (1448 kW)	3840 hp (2684 kW)
Propellers	Fixed Pitch	Variable Pitch
Passengers	81	Up to 130
Crew	5	3
Cost (psgr version)		$7.5 million U.S.[1]

1. At this time, the capital cost is a conservative estimate. A more accurate estimate must await additional design information from the builder.

The Dash 400 has an air cushion with a mean depth of 1.4 meters between the underside of the hull and the surface over which it hovers. The air cushion lifts the craft clear of the surface and is contained under the craft by a flexible skirt system around the periphery of the hull. The skirt has dynamic characteristics which enable the craft to pass over surface irregularities higher than the mean depth of the cushion. Air is continuously supplied to the cushion to make good the inevitable leakage losses around the lower edge of the skirt as it moves over uneven surfaces. Cushion pressure, and thus the ground bearing pressure, is low, approximately 2.9 kPa (60 lbs/ft^2).

SPEED ANALYSIS
AP1-88 400 HOVERCRAFT OPERATION

Segment A: The vessel is loaded and it leaves the pier at minimum power. The lift engines rev up and propulsion power is gradually increased as the vehicle gains distance from the pier and from noise sensitive areas. The vessel accelerates to pass hump speed (~14 knots) and then slowly reaches full operating speed. The vessel will keep a stern aspect to the pier area, accelerating so as to keep noise at an acceptable level for the particular terminal area. The average speed during this segment is assumed to be 20 knots.

Segment B: The vessel is at speed during the major part of the transit. Various speeds are assumed for this segment. Actual operating speed will be dictated by local regulations, discretion of the master, weather, and traffic.

Segment C: The vessel will slow as it approaches the ramp. The speed on the tarmac between the ramp and the terminal is assumed in this study to be approximated at 20 mph (17 knots)

Segment D: For scheduled planning purposes, an allowance is made for possible slowdowns owing to weather, traffic, personal emergencies, or other unavoidable situations.

Route #1 Agricultural Building (SF) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
SF(Ag Bldg)-SFO Terminal	11.5 nm	0.3nm	10.2nm	1nm		
30 knots		1	21	3	2	27
35 knots		1	18	3	2	24
40 knots		1	16	3	2	22
45 knots		1	14	3	2	20

Route #2 Larkspur (GGB&H pier) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Larkspur-SFO Terminal	23.6nm	1.8nm	20.8nm	1nm		
30 knots		5	42	3	3	53
35 knots		5	36	3	3	47
40 knots		5	31	3	3	42
45 knots		5	28	3	3	39

Route #3 San Quentin to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
San Quentin-SFO Terminal	22.8nm	1.0nm	20.8nm	1nm		
30 knots		3	42	3	3	51
35 knots		3	36	3	3	45
40 knots		3	31	3	3	40
45 knots		3	28	3	3	37

Route #4 Larkspur Site #3 (near the COSTCO Building) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Larkspur Site #3	24.5nm	1.5nm	22.0nm	1nm		
30 knots		5	44	3	3	55
35 knots		5	38	3	3	49
40 knots		5	33	3	3	44
45 knots		5	29	3	3	40

Route #5 Port Sonoma Marina(on the Petaluma River) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Port Sonoma	32.4nm	1.5 nm	29.9nm	1nm		
30 knots		5	60	3	3	71
35 knots		5	51	3	3	62
40 knots		5	45	3	3	56
45 knots		5	40	3	3	51

Route #6 Vallejo (near Cal Maritime) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Vallejo	36.6nm	1.0nm	33.6nm	1nm		
30 knots		3	67	3	3	76
35 knots		3	57	3	3	66
40 knots		3	50	3	3	59
45 knots		3	45	3	3	54

Route #7 Berkeley (Gilman Street) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Berkeley	19.1nm	1.0nm	17.1nm	1nm		
30 knots		3	34	3	3	43
35 knots		3	29	3	3	38
40 knots		3	26	3	3	35
45 knots		3	23	3	3	32

Route #8 Moffett Field (Mayfield Slough) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Moffett Field	20nm	0.3nm	18.7 nm	1nm		
30 knots		1	37	3	3	44
35 knots		1	32	3	3	39
40 knots		1	28	3	3	35
45 knots		1	25	3	3	32

HOVERCRAFT ENVIRONMENTAL & OPERATIONAL ANALYSIS

Noise: Hovercraft airborne noise is louder than most other vessels because hovercraft are propelled by air propellers similar to aircraft. Hovercraft propellers are shrouded and a great deal of effort has been spent in designing the shrouds to minimize airborne noise. Nevertheless, operating most hovercraft at full throttle in populated areas will create unacceptable noise levels at the stern quarter. The operation of hovercraft in the airport

environment should be acceptable, however, since hovercraft noise levels are a good deal lower than jet engines throttling up for take-off.

Some options for reducing noise levels in the vicinity of populated areas are the following:

- The AP1-88-400 would be fitted with controllable pitch propellers which will enable the hovercraft to reach a lower noise level at lower speeds while approaching the dock and while idling.

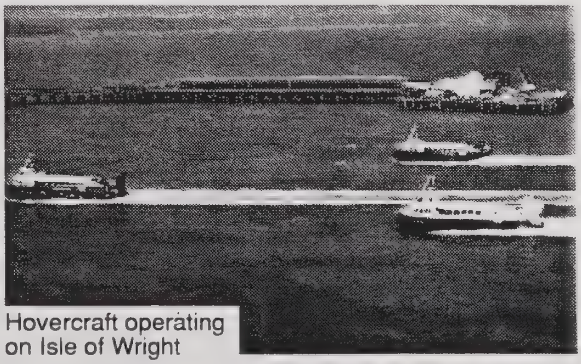
- The trainable bow thruster cowls, energized with air from the lift engines, enable the craft to maneuver at low speed approaching and leaving the dock, without revving up the propellers to unacceptable noise levels.

In the case of the AP1-88-200, readings of 96 dba were recorded at 20 meters abeam the vessel at 35 knots. The formula for translating these measurements to another point is:

If the noise was measured at a distance A from the source, at a distance B the noise level will be: $dB_b = dB_a + 20 \log_{10} (Da/Db)$. Where dB is the noise measurement in decibels and Da and Db are respectively, the distances from the source of noise measurements at points A and B.

At 100 meters, the noise level may be expected to decrease to $96 + 20 \log_{10}(20/100)$, or 96- 14=82dB. At 200 meters, the noise level will decrease to 76 dB. Thus the AP1-88-200 traveling 200 meters (650 feet) from the beach would have a beam noise of 76 dB which is an acceptable level. The closest the vessel is likely to get to land while at speed is about 700 meters (2300 feet) at Hunter's Point at which beam noise should be 55 dB.

The worst case noise reading taken on AP1-88-200 was a reading of 100dB, taken on the stern quarter at 20 meters at 35 knots. For this to be reduced to 75 dB, the vessel would have to be 350 meters or 1,100 feet from the beach and this is easily achieved. Moreover, it is expected that the Dash 400 will have lower levels yet. One of the purposes of the proposed demonstration to be held in 1998 by a Canadian Coast Guard version of the AP1-88-400 is to try various combinations of propulsion and speed to determine the optimum combination to produce minimum noise levels in approaching and leaving populated areas.



Hovercraft operating on Isle of Wright

Noise levels within the working cabin of Dash 200 have been measured as well within acceptable levels of OSHA standards. The passenger cabin of Dash 400 will be better insulated yet.

Wake Wash: Hovercraft travel above the water, and hence do not create a wake wash. They do create a depression in the their path but it does not distress either passing vehicles or shoreline property.

Operational Considerations: Hovercraft have been successfully operated for a number of years, and the technology has been continuously advanced since the 1950's. All risk factors are known, and the craft can operate safely and reliably in Bay waters.

Airfield Operations: Hovercraft have been operated, with only sporadic success, at two airports: Copenhagen and Brisbane, Australia. In their original SAS service configuration for the Copenhagen-Malmo service, the vessels were to directly access the airport terminals. During trials, however, the stability required for airfield operations required the skirts to always touch the ground. This led to excessive wear on the skirts and a decision was then made to terminate the service at a remote site and transfer passengers into the terminal. The chief advantage of hovercraft, amphibious operation, was then lost, and subsequently, the vessel was changed to a conventional catamaran.

Clearly, some form of lateral stability will be required for hovercraft to safely operate across the taxiways at San Francisco International Airport. Various alternatives will be studied during the demonstration, but the most practical solution may be attaching a yoke to the hovercraft and then using a tug to bring the vessel to the terminal gate. The yoke would essentially limit the craft's lateral movement to a few feet, and should be well within airfield safety criteria. This design should be tested as part of the proposed hovercraft demonstration in 1998. In the longer term, a separate guideway for hovercraft could be another option.

Costs: Each hovercraft, in passenger configuration, could cost up to $7.5 million U.S. Note the following chart detailing marginal operating costs:

Crew:	
Master	$ 40/hour
Senior Deck Hand	30/hour
Senior Deck Hand	30/hour
Misc. Maintenance	9/hour
Skirt Maintenance	6/hour
Prorated Overhaul	10/hour
Fuel/Lube	135/hour
Water/Sewage Service	2/hour

Estimated Marginal Operating Cost (Excluding Overhead):
$260-265 per hour

It should be noted that this cost only includes the direct (marginal) expenses associated with vessel operations, and does not include costs associated with terminal operations, supervision, security and the many other categories that are required for total system operation.

CATAMARAN TECHNOLOGY

History: The concept of dual hull craft has been in existence for many years but was only perfected in the last few decades. About thirty ago, a Norwegian naval architect took the form of a conventional monohull, split the design down the middle and moved the hulls apart, in an effort to attain a wider passenger space for a ferry of a given length. He, in effect, created more "payload space" without significantly increasing the displacement of the hull. The downside was a small increase in resistance and therefore a corresponding increase in fuel use, and a vessel of unknown seakeeping qualities and unproven structural integrity.

In practice, the advantages of symmetrical (as opposed to the early asymmetrical) hulled catamarans, coupled with advances in aluminum construction techniques, waterjet propulsion, and lightweight diesel and gas turbine engines, have made catamarans the preferred hull

form for most high speed, passenger only, ferry routes throughout the world. In most countries, but particularly in Norway and Australia, the industry has been perfected and catamarans have eclipsed monohulls, hydrofoils, and air cushion vehicles as the preferred form for areas in which water depth, weather conditions, and navigating conditions make high speed ferry operations possible. In San Francisco Bay, catamarans today serve the Oakland/Alameda/ SF Ferry Terminal route, the Vallejo/S.F. Ferry Terminal route, and will soon be added to the Larkspur/ S.F. Ferry terminal route to augment the older monohulls. For application to the airport service, the principal disadvantage of the catamaran hull form is the requirement for a shoreside landing facility (pier, float, and transfer span) and an additional transportation link from that facility to the airport terminal.

Catamaran for SFO Service: For comparison purposes, a vessel of size and capacity to maintain the route service outlined in this study will be examined. The following vessel is a representative design of the type which might be used for this service. It is similar in size to M.V. Bay Breeze, currently serving San Francisco from Alameda and Oakland, but higher powered for more speed:

Characteristic	Austral 30 M
Overall Length	30 m
Overall beam	8.7 m
Max Operating Weight	65 tonnes
Max Disposable Load	15,695 kg
Maximum Speed	33 knots
Engines	2 MTU 12V396
Total Power	3,000 kW
Propulsors	KaMeWa Waterjets
Passengers	up to 140 plus baggage
Crew	3 (depending on passenger loads)

SPEED ANALYSIS - CATAMARAN OPERATION

Segment A: The vessel is loaded, backs away, turns, and leaves the pier at minimum power, gradually accelerating to operational speed as it gets far enough away from the pier to avoid wake or noise impingement on the pier or surrounding area. A speed of 20 knots is assumed for this segment.

Segment B: The vessel is at speed during the major part of the transit. Various speeds are assumed for this segment. Actual operating speed will be dictated by local regulations, discretion of the master, weather, and traffic.

Segment C: The vessel will slow as it approaches the pier/unloading platform. Passengers will debark from the vessel and board a bus for transportation to the terminal. Luggage will be transported at the same time. Tie up time is assumed to be two minutes. The total time for 75 passengers to unload and board the buses is assumed to be 4 minutes (average 3 seconds per passenger). The bus travel to the terminal is then assumed to be 2 miles @ 20 mph or 6 minutes. Total time from arrival at the pier until arrival at the terminal is therefore 2 +4+6 = 12 minutes.

Segment D: For scheduled planning purposes, an allowance is made for possible slowdowns owing to weather, traffic, personal emergencies, or other unavoidable situations.

Route #1 Agricultural Building (SF) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
SF(Ag Bldg)-SFO Terminal	11.5 nm	0.3nm	10.2nm			
30 knots		1	21	12	2	36
35 knots		1	18	12	2	33
40 knots		1	16	12	2	31
45 knots		1	14	12	2	29

Route #2 Larkspur (GGB&H pier) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Larkspur-SFO Terminal	22.6nm	1.8nm	20.8nm			
30 knots		5	42	12	3	62
35 knots		5	36	12	3	56
40 knots		5	31	12	3	51
45 knots		5	28	12	3	48

Route #3 San Quentin to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
San Quentin-SFO Terminal	21.8nm	1.0nm	20.8nm			
30 knots		3	42	12	3	60
35 knots		3	36	12	3	54
40 knots		3	31	12	3	49
45 knots		3	28	12	3	46

Route #4 Larkspur Site #3 (near the COSTCO Building) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Larkspur Site #3	23.5nm	1.5nm	22.0nm			
30 knots		5	44	12	3	64
35 knots		5	38	12	3	58
40 knots		5	33	12	3	53
45 knots		5	29	12	3	49

Route #5 Port Sonoma Marina(on the Petaluma River) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Port Sonoma	31.4nm	1.5 nm	29.9nm			
30 knots		5	60	12	3	80
35 knots		5	51	12	3	71
40 knots		5	45	12	3	65
45 knots		5	40	12	3	60

Route #6 Vallejo (near Cal Maritime) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Vallejo	35.6nm	1.0nm	33.6nm			
30 knots		3	67	12	3	85
35 knots		3	57	12	3	75
40 knots		3	50	12	3	68
45 knots		3	45	12	3	63

Route #7 Berkeley (Gilman Street) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Berkeley	19.1nm	1.0nm	17.1nm			
30 knots		3	34	12	3	52
35 knots		3	29	12	3	47
40 knots		3	26	12	3	44
45 knots		3	23	12	3	41

Route #8 Moffett Field (Mayfield Slough) to the United Terminal (near Gate 75) at SFO:

ROUTE	TOTAL DISTANCE	A	B	C	Allowance	TOTAL
Moffett Field	19nm	0.3nm	18.7 nm			
30 knots		1	37	12	3	53
35 knots		1	32	12	3	48
40 knots		1	28	12	3	44
45 knots		1	25	12	3	41

CATAMARAN ENVIRONMENTAL & OPERATIONAL ANALYSIS

Noise: Catamaran noise appears to have been generally accepted throughout the Bay Area and is no louder, and in many cases less intrusive, than noise produced by other transportation modes.

Wake Wash: Catamaran create more wake wash than either hovercraft or catamaran — the mitigation has been to reduce speed in sensitive areas to reduce erosion and shorezone damage.

Operational Considerations: Catamaran have been successfully operated for a number of years, and the technology is now generally considered the "standard" for Bay Area ferry operations. All risk factors are known, and the craft can operate safely and reliably in Bay waters.

Costs: Each catamaran, in passenger configuration, could cost up to $6.5 million U.S. (This is a slightly more expensive version of the M.V. Bay Breeze, due to higher speed). Note the following chart detailing marginal operating costs:

Crew:	
Master	$ 40/hour
Senior Deck Hand	30/hour
Senior Deck Hand	30/hour
Misc. Maintenance	9/hour
Prorated Overhaul	7/hour
Fuel/Lube	105/hour
Water/Sewage Service	2/hour

Estimated Marginal Operating Cost (Not including overhead):
$223-230 per hour

(If a third deck hand is required, add an additional $30 per hour).

It should be noted that this cost only includes the direct (marginal) expenses associated with vessel operations, and does not include costs associated with terminal operations, supervision, security and the many other categories that are required for total system operation.

FINANCIAL ANALYSIS

A financial analysis for each of the six routes was performed. The analysis required an estimate of both revenues and expenses. Since the most likely candidate routes were downtown San Francisco to the Airport and Moffett Field to the Airport, cost models were developed for each of these routes using hovercraft. A separate cost model for downtown San Francisco to the Airport using catamaran was also developed.

As shown in Tables 7, 8 ,and 9, the total hourly operating cost for hovercraft operating between downtown San Francisco and the Airport is about $560 per hour, based on a 16 to 18 hour operating day. A combined downtown-SFO-Moffett Field operation would reduce the operating cost to about $489 hour daily. These costs include fully allocated capital and operating expenses, including lease expenses associated with the use of the vessels.

To allow for a reasonable analysis of profit and loss for all routes, the combined cost of $489 was assigned to all the other four routes; patronage was assumed at about 90-95% of the "airporter" projection. Each route, other than Moffett and downtown San Francisco, loses money.

TABLE 7
AIRPORT HOVERCRAFT (SAN FRANCISCO TO SFO) SYSTEM--
COST AND BUDGETING MODEL
SFO ONLY .- INCLUDES BOAT CAPITAL

Service Attributes		
Annual Weekday Totals	12,480 Vessel Hrs	330,720 Vessel Miles
Annual Wkend/Hlday Totals	4,200 Vessel Hrs	111,300 Vessel Miles
Total	16,680 Vessel Hrs	442,020 Vessel Miles
Vessels and Facilities		
Number of Vessels	4	
Cost of Each Vessel	$7,500,000	
Assumed Financing Rate	6.0% 20 Year Bond	
Airport/Hovercraft Landing Fees	$0	
Port Landing Fees	$0	
Maintenance Facility	7,500 Square Feet	
Captain Wages	$25.25 per hour	
Captain Fringes		Percent of Hourly Wage
Profit Sharing		
Health	$425.00 per month	9.71%
FICA	7.25%	
State Unemployment	----	1.00%
Pension	----	7.25%
Total		25.21%
Other Crew Wages	$19.00 per hour	
Other Crew Fringes		
Profit Sharing		
Health	$425.00 per month	12.90%
FICA	----	7.25%
State Unemployment	----	1.10%
Pension	----	7.25%
Total		28.50%

Vessel/Personnel Requirements	1 Captain per vessel 2Deckhands per vessel		
Absenteeism Assumptions		Percent of Total Work Time	
Vacation	120 hrs annually	5.77%	
Sick Pay	60 hrs annually	2.88%	
Unpaid Sick	10 hrs annually	0.48%	
Vacancies	10 hrs annually	0.48%	
Total		9.62%	
Scheduling Assumptions			
Pay to Platform Ratio	1.2 Ratio		
Vessels & Maintenance			
Vessel Speed	50 Knots		
Fuel used per mile	7.55 gallons		
Fuel per vessel hour	200.00 gallons		
Cost per gallon/fuel	$0.75		
Fuel cost per vessel mile	$5.66		
Fuel cost per vessel hour	$150.00		
Maintenance cost per mile	$0.30		
Skirt Maintenance cost per mile	$0.20		
Contract Maintenance (Eng O/H)	$0.35 per mile		
Materials & Supl. per mi.	$0.08		
Utility Costs per sq. foot (annual)	$8.00		
Facility Upkeep/Security per sq.'	$8.00		
Security Screening per hour		$30.00	6000 Hours
Bag Transfer per day	$500.00	11000 Hours	

Supervision Assumptions

		Rate	Salary
General Manager	1 @ 40 hours per week	$35.00	$72,800
Line Supervisors	2 @ 8 hours daily	$28.00	$163,520
Training Supervisors	1 @ 40 hours per week	$22.00	$45,760
Accounting Services	1 @ 40 hours per week	$22.00	$45,760
Clerk	3 @ 40 hours per week	$15.00	$93,600
Terminal Agent	2 @ 8 hours daily	$22.00	$128,480
Maintenance Supervisor	1 @ 40 hours per week	$28.00	$58,240

Division	Budget	Percent Variable	Cost Generation	Cost Basis	Variable Costs	Fixed Costs
Transportation						
Direct Crew Costs	$1,266,012	100%	Blue & Gold	Vessel Hours	$1,266,012	$0
Extra Board	$121,732	100%	GGT Ferry	Vessel Hours	$121,732	$0
Captain Fringes	$127,415	50%	GGT Ferry	Vessel Hours	$63,708	$63,708
Other Crew Fringes	$216,810	50%	GGT Ferry	Vessel Hours	$108,405	$108,405
Terminal Agents	$165,103	0%	GGT Ferry	Vessel Hours	$0	$165,103
Supervision	$179,243	0%	GGT Ferry	Vessel Hours	$0	$179,243
Training & Safety	$50,160	0%	GGT Ferry	Vessel Hours	$0	$50,160
Supervision/Training Fringes	$65,391	0%	GGT Ferry	Vessel Hours	$0	$65,391
Security Screening	$180,000	0%	ITS	Vessel Hours	$0	$180,000
Bag Transfer	$182,500	0%	Ogden	Vessel Hours	$0	$182,500
Vessel Financing	$2,615,537	0%	Orig. Cost + Int	Vessel Hours	$0	$2,615,537
Transportation Total	$5,169,903				$1,559,857	$3,610,047
Maintenance & Engineering						
Vessels						
Vessels-Fuels/Lubes	$2,502,938	100%	Mfg Estimates	Vessel Miles	$2,502,938	$0
Vessel Service Wk	$221,010	70%	Mfg Estimates	Vessel Miles	$157,707	$66,303
Contract Maint. (Engine O/H)	$154,707	100%	Mfg Estimates	Vessel Miles	$154,707	$0
Materials & Supply	$33,152	50%	Mfg Estimates	Vessel Miles	$16,576	$16,576
Facilities & Terminals						
Repairs & Upkeep	$60,000	0%	GGT Ferry	Vessel Hours	$0	$60,000
Facility Utilities	$60,000	0%	GGT Ferry	Vessel Hours	$0	$60,000
Rentals & Port Fees	$0	0%	Port of SF	Vessel Hours	$0	$0
General Engineering	$100,000	0%	GGT Ferry	Vessel Hours	$0	$100,000
Maintenance Supervision	$74,841	0%	GGT Ferry	Vessel Hours	$0	$74,841
Maintenance Total	$3,206,648				$2,828,928	$377,720

Division	Budget	Percent Variable	Cost Generation	Cost Basis	Variable Costs	Fixed Costs	
Administration							
Planning & Scheduling	$100,000	0%	Contract	Vessel Hours	$0	$100,000	
Public Info & Marketing	$325,000	0%	SFO Airporter	Vessel Hours	$0	$325,000	
General Administration	$272,636	0%	GGT Ferry	Vessel Hours	$0	$272,636	
Risk Mgt/Claims/Work Cmp	$370,000	0%	GGT Ferry	Vessel Hours	$0	$370,000	
Administration Total	$1,067,636				$0	$1,067,636	
Depreciation		0%		Vessel Cost			
Grand Total (not includ dep)	$9,444,187			Variable Total	$4,388,785	$5,055,403	Fixed Total
check	$9,444,187						

FULLY ALLOCATED COSTS
AIRPORT HOVERCRAFT SYSTEM

Summary

Vehicle Hours	Rate	Cost
0.0	$566	$0

Ferryboat:

Units	# of Units	Unit Cost	Cost of Service
Vessel Hours	1.00	$234.82	$235
Vessel Miles	26.5	$6.59	$175
Vessel Capital	1.00	$157	$157
Total			$566

VARIABLE COSTS
AIRPORT HOVERCRAFT SYSTEM

Summary

Vehicle Hours	Rate	Cost
0.0	$263	$0

Ferryboat:

Units	# of Units	Unit Cost	Cost of Service
Vessel Hours	1.00	$93.52	$94
Vessel Miles	26.5	$6.40	$170
Total			$263

TABLE 8
AIRPORT HOVERCRAFT (SAN FRANCISCO TO SFO, MOFFETT FIELD TO SFO) SYSTEM-- COST AND BUDGETING MODEL - INCLUDES BOAT CAPITAL

Service Attributes		
Annual Weekday Totals	29,000 Vessel Hrs	904,800 Vessel Miles
Annual Wkend/Hlday Totals	9,500 Vessel Hrs	300,000 Vessel Miles
Total	38,500 Vessel Hrs	1,204,800 Vessel Miles

Vessels and Facilities	
Number of Vessels	9
Cost of Each Vessel	$7,500,000
Assumed Financing Rate	6.0% 20 Year Bond
Airport/Hovercraft Landing Fees	$0
Port Landing Fees	$0
Maintenance Facility	7,500 Square Feet

Captain Wages	$25.25 per hour	
Captain Fringes		Percent of Hourly Wage
Profit Sharing		
Health	$425.00 per month	9.71%
FICA	7.25%	
State Unemployment	----	1.00%
Pension	----	7.25%
Total		25.21%

Other Crew Wages	$19.00 per hour	
Other Crew Fringes		
Profit Sharing		
Health	$425.00 per month	12.90%
FICA	----	7.25%
State Unemployment	----	1.10%
Pension	----	7.25%
Total		28.50%

Vessel/Personnel Requirements	1 Captain per vessel 2Deckhands per vessel

Absenteeism Assumptions		Percent of Total Work Time
Vacation	120 hrs annually	5.77%
Sick Pay	60 hrs annually	2.88%
Unpaid Sick	10 hrs annually	0.48%
Vacancies	10 hrs annually	0.48%
Total		9.62%

Scheduling Assumptions

Pay to Platform Ratio	1.2 Ratio	
Vessels & Maintenance		
Vessel Speed	50 Knots	
Fuel used per mile	6.4 gallons	
Fuel per vessel hour	200.00 gallons	
Cost per gallon/fuel	$0.75	
Fuel cost per vessel mile	$4.80	
Fuel cost per vessel hour	$150.00	
Maintenance cost per mile	$0.30	
Skirt Maintenance cost per mile	$0.20	
Contract Maintenance (Engine O/H)	$0.35 per mile	
Materials & Supl. per mi.	$0.08	
Utility Costs per sq. foot (annual)	$8.00	
Facility Upkeep/Security per sq.'	$8.00	
Security Screening per hour	$30.00	6000 Hours
Bag Transfer per day	$500.00	11000 Hours

Supervision Assumptions

		Rate	Salary
General Manager	1 @ 40 hours per week	$35.00	$72,800
Line Supervisors	2 @ 8 hours daily	$28.00	$163,520
Training Supervisors	1 @ 40 hours per week	$22.00	$45,760
Accounting Services	1 @ 40 hours per week	$22.00	$45,760
Clerk	3 @ 40 hours per week	$15.00	$93,600
Terminal Agent	2 @ 8 hours daily	$22.00	$128,480
Maintenance Supervisor	1 @ 40 hours per week	$28.00	$58,240

Division	**Budget**	**Percent Variable**	**Cost Generation**	**Cost Basis**	**Variable Costs**	**Fixed Costs**
Transportation						
Direct Crew Costs .	$2,922,150	100%	Blue & Gold	Vessel Hours	$2,922,150	$0
Extra Board	$280,976	100%	GGT Ferry	Vessel Hours	$280,976	$0
Captain Fringes	$294,094	50%	GGT Ferry	Vessel Hours	$147,047	$147,047
Other Crew Fringes	$500,431	50%	GGT Ferry	Vessel Hours	$250,216	$250,216
Terminal Agents	$165,103	0%	GGT Ferry	Vessel Hours	$0	$165,103
Supervision	$179,243	0%	GGT Ferry	Vessel Hours	$0	$179,243
Training & Safety	$50,160	0%	GGT Ferry	Vessel Hours	$0	$50,160
Supervision/Training Fringes	$65,391	0%	GGT Ferry	Vessel Hours	$0	$65,391
Security Screening	$180,000	0%	ITS	Vessel Hours	$0	$180,000
Bag Transfer	$182,500	0%	Ogden	Vessel Hours	$0	$182,500
Vessel Financing	$5,884,958	0%	Orig. Cost + Int	Vessel Hours	$0	$5,884,958
Transportation Total	$10,705,006				$3,600,389	$7,104,617
Maintenance & Engineering						
Vessels						
Vessels-Fuels/Lubes	$5,783,040	100%	Mfg Estimates	Vessel Miles	$5,783,040	$0
Vessel Service Wk	$602,400	70%	Mfg Estimates	Vessel Miles	$421,680	$180,720
Contract Maint. (Engine O/H)	$154,707	100%	Mfg Estimates	Vessel Miles	$154,707	$0
Materials & Supply	$33,152	50%	Mfg Estimates	Vessel Miles	$16,576	$16,576

Division	Budget	Percent Variable	Cost Generation	Cost Basis	Variable Costs	Fixed Costs	
Facilities & Terminals							
Repairs & Upkeep	$60,000	0%	GGT Ferry	Vessel Hours	$0	$60,000	
Facility Utilities	$60,000	0%	GGT Ferry	Vessel Hours	$0	$60,000	
Rentals & Port Fees	$0	0%	Port of SF	Vessel Hours	$0	$0	
General Engineering	$100,000	0%	GGT Ferry	Vessel Hours	$0	$100,000	
Maintenance Supervision	$74,841	0%	GGT Ferry	Vessel Hours	$0	$74,841	
Maintenance Total	$6,868,140				$6,376,003	$492,137	
Administration							
Planning & Scheduling	$100,000	0%	Contract	Vessel Hours	$0	$100,000	
Public Info & Marketing	$325,000	0%	SFO Airporter	Vessel Hours	$0	$325,000	
General Administration	$272,636	0%	GGT Ferry	Vessel Hours	$0	$272,636	
Risk Mgt/Claims/Work Cmp	$557,500	0%	GGT Ferry	Vessel Hours	$0	$557,500	
Administration Total	$1,255,136				$0	$1,255,136	
Depreciation		0%	Vessel Cost				
Grand Total (not includ dep)	$18,828,282		Variable Total		$9,976,391	$8,851,890	Fixed Total
check	$18,828,282						

FULLY ALLOCATED COSTS
AIRPORT HOVERCRAFT SYSTEM

Summary

Vehicle Hours	Rate	Cost
0.0	$489	$0

Ferryboat:

Units	# of Units	Unit Cost	Cost of Service
Vessel Hours	1.00	$165.46	$165
Vessel Miles	31.3	$5.46	$171
Vessel Capital	1.00	$153	$153
Total			$489

VARIABLE COSTS
AIRPORT HOVERCRAFT SYSTEM

Summary

Vehicle Hours	Rate	Cost
0.0	$259	$0

Ferryboat:

Units	# of Units	Unit Cost	Cost of Service
Vessel Hours	1.00	$93.52	$94
Vessel Miles	31.3	$5.29	$166
Total			$259

TABLE 9
AIRPORT CATAMARAN (SAN FRANCISCO TO SFO) SYSTEM--COST AND BUDGETING MODEL
SFO ONLY - INCLUDES BOAT CAPITAL

Service Attributes		
Annual Weekday Totals	12,480 Vessel Hrs	330,720 Vessel Miles
Annual Wkend/Hlday Totals	4,200 Vessel Hrs	111,300 Vessel Miles
Total	16,680 Vessel Hrs	442,020 Vessel Miles

Vessels and Facilities	
Number of Vessels	4
Cost of Each Vessel	$6,000,000
Assumed Financing Rate	6.0% 20 Year Bond
Airport/Hovercraft Landing Fees	$0
Port Landing Fees	$0
Maintenance Facility	7,500 Square Feet

Captain Wages	$25.25 per hour	
Captain Fringes		Percent of Hourly Wage
Profit Sharing		
Health	$425.00 per month	9.71%
FICA	7.25%	
State Unemployment	----	1.00%
Pension	----	7.25%
Total		25.21%

Other Crew Wages	$19.00 per hour	
Other Crew Fringes		
Profit Sharing		
Health	$425.00 per month	12.90%
FICA	----	7.25%
State Unemployment	----	1.10%
Pension	----	7.25%
Total		28.50%

Vessel/Personnel Requirements	1 Captain per vessel 2Deckhands per vessel

Absenteeism Assumptions		Percent of Total Work Time
Vacation	120 hrs annually	5.77%
Sick Pay	60 hrs annually	2.88%
Unpaid Sick	10 hrs annually	0.48%
Vacancies	10 hrs annually	0.48%
Total		9.62%

Scheduling Assumptions

Pay to Platform Ratio	1.2 Ratio	
Vessels & Maintenance		
Vessel Speed	40 Knots	
Fuel used per mile	7 gallons	
Fuel per vessel hour	185.42 gallons	
Cost per gallon/fuel	$0.75	
Fuel cost per vessel mile	$5.25	
Fuel cost per vessel hour	$139.07	
Maintenance cost per mile	$0.25	
Contract Maintenance (Engine O/H)	$0.30 per mile	
Materials & Supl. per mi.	$0.03	
Utility Costs per sq. foot (annual)	$8.00	
Facility Upkeep/Security per sq.'	$8.00	
Security Screening per hour	$30.00	6000 Hours
Bag Transfer per day	$500.00	11000 Hours

Supervision Assumptions

		Rate	Salary
General Manager	1 @ 40 hours per week	$35.00	$72,800
Line Supervisors	2 @ 8 hours daily	$28.00	$163,520
Training Supervisors	1 @ 40 hours per week	$22.00	$45,760
Accounting Services	1 @ 40 hours per week	$22.00	$45,760
Clerk	3 @ 40 hours per week	$15.00	$93,600
Terminal Agent	2 @ 8 hours daily	$22.00	$128,480
Maintenance Supervisor	1 @ 40 hours per week	$28.00	$58,240

Division	Budget	Percent Variable	Cost Generation	Cost Basis	Variable Costs	Fixed Costs
Transportation						
Direct Crew Costs	$1,266,012	100%	Blue & Gold	Vessel Hours	$1,266,012	$0
Extra Board	$121,732	100%	GGT Ferry	Vessel Hours	$121,732	$0
Captain Fringes	$127,415	50%	GGT Ferry	Vessel Hours	$63,708	$63,708
Other Crew Fringes	$216,810	50%	GGT Ferry	Vessel Hours	$108,405	$108,405
Terminal Agents	$165,103	0%	GGT Ferry	Vessel Hours	$0	$165,103
Supervision	$179,243	0%	GGT Ferry	Vessel Hours	$0	$179,243
Training & Safety	$50,160	0%	GGT Ferry	Vessel Hours	$0	$50,160
Supervision/Training Fringes	$65,391	0%	GGT Ferry	Vessel Hours	$0	$65,391
Security Screening	$180,000	0%	ITS	Vessel Hours	$0	$180,000
Bag Transfer	$182,500	0%	Ogden	Vessel Hours	$0	$182,500
Vessel Financing	$2,092,429	0%	Orig. Cost + Int	Vessel Hours	$0	$2,092,429
Transportation Total	$4,646,796				$1,559,857	$3,086,939

Division	Budget	Percent Variable	Cost Generation	Cost Basis	Variable Costs	Fixed Costs	
Maintenance & Engineering							
Vessels							
Vessels-Fuels/Lubes	$2,320,605	100%	Mfg Estimates	Vessel Miles	$2,320,605	$0	
Vessel Service Wk	$110,505	70%	Mfg Estimates	Vessel Miles	$77,354	$33,152	
Contract Maint. (Engine O/H)	$132,606	100%	Mfg Estimates	Vessel Miles	$132,606	$0	
Materials & Supply	$11,051	50%	Mfg Estimates	Vessel Miles	$5,525	$5,525	
Facilities & Terminals							
Repairs & Upkeep	$60,000	0%	GGT Ferry	Vessel Hours	$0	$60,000	
Facility Utilities	$60,000	0%	GGT Ferry	Vessel Hours	$0	$60,000	
Rentals & Port Fees	$0	0%	Port of SF	Vessel Hours	$0	$0	
General Engineering	$100,000	0%	GGT Ferry	Vessel Hours	$0	$100,000	
Maintenance Supervision	$74,841	0%	GGT Ferry	Vessel Hours	$0	$74,841	
Maintenance Total	$2,869,608				$2,536,090	$333,518	
Administration							
Planning & Scheduling	$100,000	0%	Contract	Vessel Hours	$0	$100,000	
Public Info & Marketing	$325,000	0%	SFO Airporter	Vessel Hours	$0	$325,000	
General Administration	$272,636	0%	GGT Ferry	Vessel Hours	$0	$272,636	
Risk Mgt/Claims/Work Cmp	$340,000	0%	GGT Ferry	Vessel Hours	$0	$340,000	
Administration Total	$1,037,636				$0	$1,037,636	
Depreciation		0%	Vessel Cost				
Grand Total (not includ dep)	$8,554,040		Variable Total		$4,095,946	$4,458,093	Fixed Total
check	$8,554,040						

FULLY ALLOCATED COSTS AIRPORT CATAMARAN SYSTEM

Summary

Vehicle Hours	Rate	Cost
0.0	$513	$0

Ferryboat:

Units	# of Units	Unit Cost	Cost of Service
Vessel Hours	1.00	$233.02	$233
Vessel Miles	26.50	$5.83	$154
Vessel Capital	1.00	$125	$125
Total			$513

VARIABLE COSTS AIRPORT CATAMARAN SYSTEM

Summary

Vehicle Hours	Rate	Cost
0.0	$246	$0

Ferryboat:

Units	# of Units	Unit Cost	Cost of Service
Vessel Hours	1.00	$93.52	$94
Vessel Miles	26.5	$5.74	$152
Total			$246

Note the following tables detailing profit and loss expectations at Berkeley, Marin, Port Sonoma, and Vallejo:

TABLE 10
BERKELEY ROUTE
PROFIT AND LOSS ANALYSIS

Route:	Berkeley
Mode:	Hovercraft
Sailing Time:	35 minutes
Service Span:	16 hours
Parking Type:	Surface Auto
Hourly Cost:	
Operations	$135
Maintenance	$171
Vessel Pmts	$153
Misc A/P Costs	$30
Frequency:	30 min headways
Vessels Req:	3
Tug Req:	2
Vessel Cost:	$7,500,000
Interest Rate:	6.0% 20 year loan
Fare:	$12
Parking Rate:	$8
Passengers:	550
Parking Demand:	250
Operating Cost:	$14,688
Vessel Capital Cost:	$7,344
Tug Operating Cost:	$960
Parking Land Cost:	$0
Passenger Rev:	$6,600
Parking Revenue:	$2,000
Profit/(Loss) — Without Capital	($5,048) ($1,514,400) annual
Profit/(Loss) — Paying Capital	($12,392) ($3,717,600) annual

TABLE 11
MARIN ROUTE
PROFIT AND LOSS ANALYSIS

Route:	Marin
Mode:	Hovercraft
Sailing Time:	35 minutes
Service Span:	16 hours
Parking Type:	Surface Auto
Hourly Cost:	
Operations	$135
Maintenance	$171
Vessel Pmts	$153
Misc A/P Costs	$30
Frequency:	30 min headways
Vessels Req:	3
Tug Req:	2
Vessel Cost:	$7,500,000
Interest Rate:	6.0% 20 year loan
Fare: $12	
Parking Rate:	$8
Passengers:	475
Parking Demand:	250
Operating Cost:	$14,688
Vessel Capital Cost:	$7,344
Tug Operating Cost:	$960
Parking Land Cost:	$0
Passenger Rev:	$5,700
Parking Revenue:	$2,000
Profit/(Loss) — Without Capital	($5,948) ($1,784,400) annual
Profit/(Loss) — Paying Capital	($13,292) ($3,987,600) annual

TABLE 12
PORT SONOMA ROUTE
PROFIT AND LOSS ANALYSIS

Route:	Port Sonoma	
Mode:	Hovercraft	
Sailing Time:	56	minutes
Service Span:	16	hours
Parking Type:	Surface Auto	
Hourly Cost:		
Operations	$135	
Maintenance	$171	
Vessel Pmts	$153	
Misc A/P Costs	$30	
Frequency:	30 min headways	
Vessels Req:	4	
Tug Req:	2	
Vessel Cost:	$7,500,000	
Interest Rate:	6.0% 20 year loan	
Fare:	$12	
Parking Rate:	$8	
Passengers:	580	
Parking Demand:	250	
Operating Cost:	$19,584	
Vessel Capital Cost:	$9,792	
Tug Operating Cost:	$960	
Parking Land Cost:	$0	
Passenger Rev:	$6,960	
Parking Revenue:	$2,000	
Profit/(Loss) — Without Capital	($9,584) ($2,875,200) annual	
Profit/(Loss) — Paying Capital	($19,376) ($5,812,800) annual	

TABLE 13
VALLEJO ROUTE
PROFIT AND LOSS ANALYSIS

Route:	Vallejo	
Mode:	Hovercraft	
Sailing Time:	60	minutes
Service Span:	16	hours
Parking Type:	Surface Auto	
Hourly Cost:		
Operations	$135	
Maintenance	$171	
Vessel Pmts	$153	
Misc A/P Costs	$30	
Frequency:	30 min headways	
Vessels Req:	5	
Tug Req:	2	
Vessel Cost:	$7,500,000	
Interest Rate:	6.0% 20 year loan	
Fare:	$12	
Parking Rate:	$8	
Passengers:	530	
Parking Demand:	250	
Operating Cost:	$24,480	
Vessel Capital Cost:	$12,240	
Tug Operating Cost:	$960	
Parking Land Cost:	$0	
Passenger Rev:	$6,360	
Parking Revenue:	$2,000	
Profit/(Loss) — Without Capital	($15,080) ($4,524,000) annual	
Profit/(Loss) — Paying Capital	($27,320) ($8,196,000) annual	

The conclusion that can be made from this analysis is that only downtown San Francisco and Moffett Field should be considered as candidate routes. Every other route loses substantial amounts of money.

A similar analysis of costs at downtown San Francisco and at Moffett Field reveals a profitable operation, even after paying for vessels (in the case of downtown San Francisco, the operation is costed out assuming there is no other service, resulting in a higher hourly operating cost):

TABLE 14
DOWNTOWN SF ROUTE
PROFIT AND LOSS ANALYSIS

Route:	Downtown SF
Mode:	Hovercraft
Sailing Time:	22 minutes
Service Span:	16 hours
Parking Type:	None
Hourly Cost:	
Operations	$205
Maintenance	$175
Vessel Pmts	$157
Misc A/P Costs	$30
Frequency:	20 min headways
Vessels Req:	3
Tug Req:	2
Vessel Cost:	$7,500,000
Interest Rate:	6.0% 20 year loan
Fare:	$10
Parking Rate:	$8
Passengers:	3600
Parking Demand:	0
Operating Cost:	$18,240
Vessel Capital Cost:	$7,536
Tug Operating Cost:	$960
Parking Land Cost:	$0
Passenger Rev:	$36,000
Parking Revenue:	$0
Profit/(Loss) — Without Capital	$16,800 $5,040,000 annual
Profit/(Loss) — Paying Capital	$9,264 $2,779,200 annual

TABLE 15
MOFFETT FIELD ROUTE
PROFIT AND LOSS ANALYSIS

Route:	Moffett Field
Mode:	Hovercraft
Sailing Time:	35 minutes
Service Span:	16 hours
Parking Type:	Surface Auto
Hourly Cost:	
Operations	$135
Maintenance	$171
Vessel Pmts	$153
Misc A/P Costs	$30
Frequency:	20 min headways
Vessels Req:	4
Tug Req:	2
Vessel Cost:	$7,500,000
Interest Rate:	6.0% 20 year loan
Fare:	$10
Parking Rate:	$8
Passengers:	1200
Parking Demand:	900
Operating Cost:	$19,584
Vessel Capital Cost:	$9,792
Tug Operating Cost:	$960
Parking Land Cost:	$0
Passenger Rev:	$12,000
Parking Revenue:	$8,000
Profit/(Loss) — Without Capital	$7,456 $2,236,800 annual
Profit/(Loss) — Paying Capital	($2,336) ($700,800) annual

At Moffett Field the presence of an unconstrained parking supply allows a system operator to generate a substantial revenue stream from automobile parking, greatly increasing system revenues. In addition, the operation of two routes results in a lower hourly operating cost than the operation of just one route.

ASSUMPTIONS OF THE FINANCING PLAN

The Financial Plan assumes that all costs are borne from the system revenues, including those costs associated with vessel leasing and or purchase. However, there is no provision for terminal costs, which are discussed separately. Annual costs are based on a 300 day operation — this assumption allows the operator to plan for less service on slower days while still retaining a reasonable cost guide.

The costs included here are based on existing and proven hovercraft operating costs, notably from the Canadian Coast Guard, which has operated hovercraft for several years in Vancouver Harbor. Each vessel is assumed to cost $7.5 million (U.S.) and is proposed to be financed at about a six percent interest rate through the federal Maritime Administration's (Department of Transportation) Title XI vessel financing program.

The Tital XI program provides a loan guarantee to a commercial bank or other lending organization (such as a pension fund or insurance company) when it loans money to entities building ships in the United States. This report assumes that the Airport would use its good offices to assist in securing loan guarantees through the Maritime Administration of about $65 million for 10 vessels. The remaining funds would be outside capital required by the government as down-payment. The payment schedule for this money is included in the hourly cost estimates.

It should be noted that in 1997 the Maritime Administration guaranteed about $30 in loans to assist in the construction of catamarans for the west coast of Florida. California has not been a significant recipient of these guarantees.

Other financing avenues be considered but would likely result in additional interest costs. Commercial banks have loaned funds for ships in the past to qualified operators (the Ohlone Spirit catamaran was initially financed by bank loans). Leasing is also another option, and San Francisco leasing professionals have expressed interest in providing financing should the "right" project materialize.

FREIGHT ANALYSIS

OVERVIEW

As part of this study, the consultant team analyzed the potential for shuttling cargo to and from San Francisco International Airport on the Bay's waterways. *Working Paper Number 4* details the results of this analysis, but in general the findings are as follows:

- Congestion is considered a serious and growing problem for the air cargo industry. Eighty-three percent of the respondents surveyed cite highway and bridge congestion as an operating problem. All of these respondents note that the problem is growing and eighty-seven percent feel that the problem is serious .

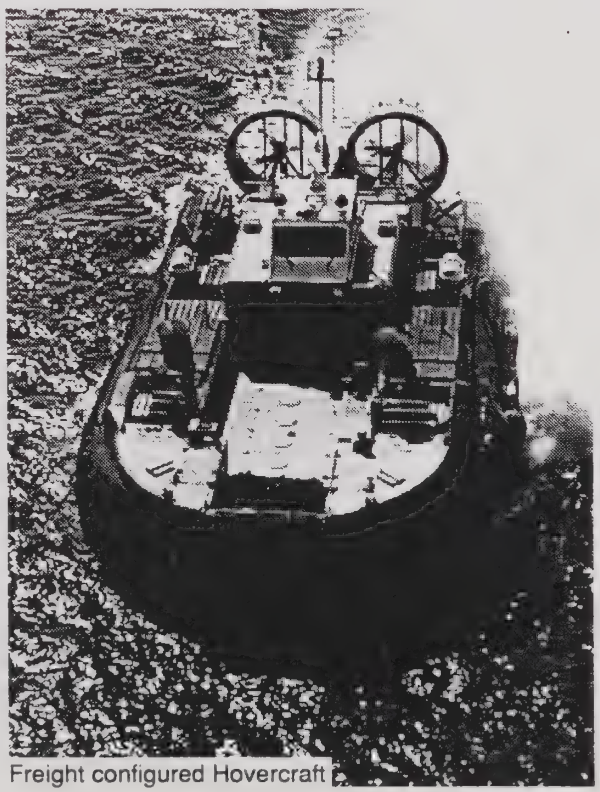
- Air cargo is a candidate for freight ferry diversion form trucks. Seventy-two percent of the survey respondents feel that a fast ferry system could divert a portion of the air cargo market from trucking. Eighty-four percent of these respondents note that there is a current need for such an alternative service.

- High-speed ferries are essential since air cargo is extremely time sensitive. Aircraft receiving cut-off times and estimated roadway congestion patterns drive customer pickup schedules. Reduction in congestion and normalization of local delivery schedules may help expand access to more cargo by extending cut-off times.

- SFO's best target market for international cargo is southern Alameda County, Santa Clara County and southern San Mateo County. Use of Moffett Field as a port-pair site with SFO should be reviewed to possibly serve this market. International cargo in these areas totals more than 500 metric tons daily.

- SFO's best target market for domestic cargo is San Francisco County, southern San Mateo County and Santa Clara County. Domestic cargo between downtown San Francisco and SFO totals between 75 and 150 metric tons daily — International cargo is another 30 to 50 tons daily. Use of Moffett Field and a downtown San Francisco waterfront location as port-pair sites with SFO may represent an operationally viable and marketable opportunity.

- Customizable, independently-operated, multi-user facilities should be studied. Since there are so many forwarder-brokers and carriers, each having a relatively small market share,



Freight configured Hovercraft

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any individual company probably could not solely bear the costs of a facility. However, such facilities should have the ability to be customized to meet customer needs and schedules. SFO may want to consider creating off-site facilities at Moffett Field and on the downtown San Francisco waterfront to serve their customers.

- Customizable, independently-operated, multi-user ferries should be studied. Since there are so many forwarder-brokers and carriers, each having a relatively small market share, any individual company probably could not solely bear the costs of a service. However, such services should have the ability to be customized to meet customer needs and schedules. A joint passenger/cargo operation is possible. Ferries and facilities should provide for flexibility in modes of handling cargo. Based on time sensitivity and the costs to rehandle cargo, ferries and facilities should be studied that can handle loose freight and containerization. Some survey respondents indicated that roll-on, roll-off ferries which could accommodate trucks were needed, however, they may not be practical.

- Amphibious ferries would provide greater flexibility in sites and routes. Due to limited water depth and the restrictions on locations of potential shoreside facilities, amphibious craft should be studied.

- The so-called air courier freight market, based on SFO's small market share, does not seem to be a logical market for SFO to pursue and is outside the scope of this study. However, SFO's courier airfreight market may be able to be handled in conjunction with belly carriers.

SUGGESTED NEXT STEPS

The most likely scenario to implement air-related cargo would probably involve a joint operation with a proposed passenger service. Should a passenger service operator be franchised, then that operator should establish a model for freight ferry operating costs. Alternatively, the facility operators (such as a port or airport) could conduct the study. This analysis would include a calculation of the full and marginal costs for various operating scenarios for loose freight and containerized cargo both independently and in conjunction with passenger services.

The operator's study should also determine a cost model for land-leg operating revenues available to fund a ferry service. Since a ferry service would be an added cost to operations, an important task in the study would calculate the net revenues available for a ferry service.

Finally, the operator should determine the port-pair capture-rate necessary to finance a ferry system. Using the cost-models for operating costs and available revenues, the study should calculate the throughput necessary to finance a freight ferry system.

If there is a reasonable capture-rate, the study would then determine preliminary operating and financial feasibility of target port-pairs and services.

RECOMMENDED OPERATING AND FACILITIES PLAN

RECOMMENDED OPERATING PLAN

Both the Market Analysis and the Financial Analysis indicate that a hovercraft service operating between downtown San Francisco and Moffett Field to San Francisco International Airport would be a viable service and would be profitable. Within each catchment area hovercraft services would capture a market share of between 10 and 15 percent.

To provide the services levels which generate this market demand, hovercraft would operate 16 to 17 hours daily every 20 minutes. Note the attached schedule:

TABLE 16
POSSIBLE TIMETABLE

Lv Moffett Fd	Lv Ag Bldg	Ar SFO	Lv SFO	Ar Ag Bldg	Ar Moffett Fd
06:00 AM		06:35 AM	06:40 AM		07:15 AM
	06:20 AM	06:42 AM	06:50 AM	07:12 AM	
06:20 AM		06:55 AM	07:00 AM		07:35 AM
	06:40 AM	07:02 AM	07:10 AM	07:32 AM	
06:40 AM		07:15 AM	07:20 AM		07:55 AM
	07:00 AM	07:22 AM	07:30 AM	07:52 AM	
07:00 AM		07:35 AM	07:40 AM		08:15 AM
	07:20 AM	07:42 AM	07:50 AM	08:12 AM	
07:20 AM		07:55 AM	08:00 AM		08:35 AM
	07:40 AM	08:02 AM	08:10 AM	08:32 AM	
07:40 AM		08:15 AM	08:20 AM		08:55 AM
	08:00 AM	08:22 AM	08:30 AM	08:52 AM	
08:00 AM		08:35 AM	08:40 AM		09:15 AM
	08:20 AM	08:42 AM	08:50 AM	09:12 AM	
08:20 AM		08:55 AM	09:00 AM		09:35 AM
	08:40 AM	09:02 AM	09:10 AM	09:32 AM	
08:40 AM		09:15 AM	09:20 AM		09:55 AM
	09:00 AM	09:22 AM	09:30 AM	09:52 AM	
09:00 AM		09:35 AM	09:40 AM		10:15 AM
	09:20 AM	09:42 AM	09:50 AM	10:12 AM	
09:20 AM		09:55 AM	10:00 AM		10:35 AM
	09:40 AM	10:02 AM	10:10 AM	10:32 AM	
09:40 AM		10:15 AM	10:20 AM		10:55 AM
	10:00 AM	10:22 AM	10:30 AM	10:52 AM	
10:00 AM		10:35 AM	10:40 AM		11:15 AM
	10:20 AM	10:42 AM	10:50 AM	11:12 AM	
10:20 AM		10:55 AM	11:00 AM		11:35 AM
	10:40 AM	11:02 AM	11:10 AM	11:32 AM	
10:40 AM		11:15 AM	11:20 AM		11:55 AM
	11:00 AM	11:22 AM	11:30 AM	11:52 AM	
11:00 AM		11:35 AM	11:40 AM		12:15 PM
	11:20 AM	11:42 AM	11:50 AM	12:12 PM	
11:20 AM		11:55 AM	12:00 PM		12:35 PM
	11:40 AM	12:02 PM	12:10 PM	12:32 PM	

Lv Moffett Fd	Lv Ag Bldg	Ar SFO	Lv SFO	Ar Ag Bldg	Ar Moffett Fd
11:40 AM		12:15 PM	12:20 PM		12:55 PM
	12:00 PM	12:22 PM	12:30 PM	12:52 PM	
12:00 PM		12:35 PM	12:40 PM		01:15 PM
	12:20 PM	12:42 PM	12:50 PM	01:12 PM	
12:20 PM		12:55 PM	01:00 PM		01:35 PM
	12:40 PM	01:02 PM	01:10 PM	01:32 PM	
12:40 PM		01:15 PM	01:20 PM		01:55 PM
	01:00 PM	01:22 PM	01:30 PM	01:52 PM	
01:00 PM		01:35 PM	01:40 PM		02:15 PM
	01:20 PM	01:42 PM	01:50 PM	02:12 PM	
01:20 PM		01:55 PM	02:00 PM		02:35 PM
	01:40 PM	02:02 PM	02:10 PM	02:32 PM	
01:40 PM		02:15 PM	02:20 PM		02:55 PM
	02:00 PM	02:22 PM	02:30 PM	02:52 PM	
02:00 PM		02:35 PM	02:40 PM		03:15 PM
	02:20 PM	02:42 PM	02:50 PM	03:12 PM	
02:20 PM		02:55 PM	03:00 PM		03:35 PM
	02:40 PM	03:02 PM	03:10 PM	03:32 PM	
02:40 PM		03:15 PM	03:20 PM		03:55 PM
	03:00 PM	03:22 PM	03:30 PM	03:52 PM	
03:00 PM		03:35 PM	03:40 PM		04:15 PM
	03:20 PM	03:42 PM	03:50 PM	04:12 PM	
03:20 PM		03:55 PM	04:00 PM		04:35 PM
	03:40 PM	04:02 PM	04:10 PM	04:32 PM	
03:40 PM		04:15 PM	04:20 PM		04:55 PM
	04:00 PM	04:22 PM	04:30 PM	04:52 PM	
04:00 PM		04:35 PM	04:40 PM		05:15 PM
	04:20 PM	04:42 PM	04:50 PM	05:12 PM	
04:20 PM		04:55 PM	05:00 PM		05:35 PM
	04:40 PM	05:02 PM	05:10 PM	05:32 PM	
04:40 PM		05:15 PM	05:20 PM		05:55 PM
	05:00 PM	05:22 PM	05:30 PM	05:52 PM	
05:00 PM		05:35 PM	05:40 PM		06:15 PM
	05:20 PM	05:42 PM	05:50 PM	06:12 PM	
05:20 PM		05:55 PM	06:00 PM		06:35 PM
	05:40 PM	06:02 PM	06:10 PM	06:32 PM	
05:40 PM		06:15 PM	06:20 PM		06:55 PM
	06:00 PM	06:22 PM	06:30 PM	06:52 PM	
06:00 PM		06:35 PM	06:40 PM		07:15 PM
	06:20 PM	06:42 PM	06:50 PM	07:12 PM	
06:20 PM		06:55 PM	07:00 PM		07:35 PM
	06:40 PM	07:02 PM	07:10 PM	07:32 PM	
06:40 PM		07:15 PM	07:20 PM		07:55 PM
	07:00 PM	07:22 PM	07:30 PM	07:52 PM	
07:00 PM		07:35 PM	07:40 PM		08:15 PM
	07:20 PM	07:42 PM	07:50 PM	08:12 PM	
07:20 PM		07:55 PM	08:00 PM		08:35 PM
	07:40 PM	08:02 PM	08:10 PM	08:32 PM	
07:40 PM		08:15 PM	08:20 PM		08:55 PM
	08:00 PM	08:22 PM	08:30 PM	08:52 PM	
08:00 PM		08:35 PM	08:40 PM		09:15 PM
	08:20 PM	08:42 PM	08:50 PM	09:12 PM	
08:20 PM		08:55 PM	09:00 PM		09:35 PM

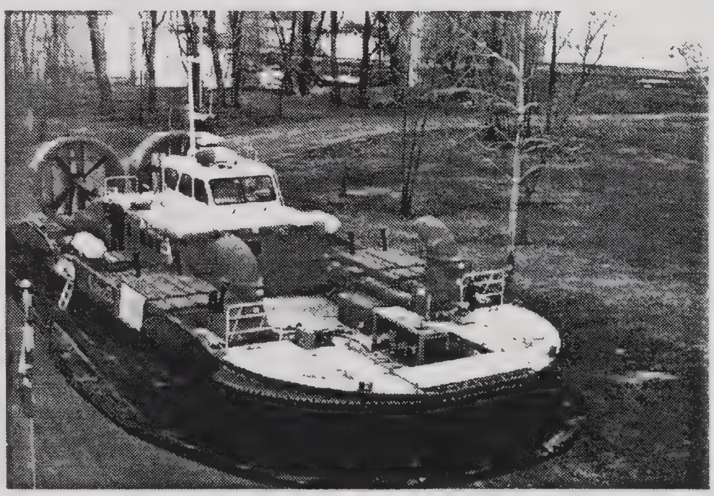
Lv Moffett Fd	Lv Ag Bldg	Ar SFO	Lv SFO	Ar Ag Bldg	Ar Moffett Fd
	08:40 PM	09:02 PM	09:10 PM	09:32 PM	
08:40 PM		09:15 PM	09:20 PM		09:55 PM
	09:00 PM	09:22 PM	09:30 PM	09:52 PM	
09:00 PM		09:35 PM	09:40 PM		10:15 PM
	09:20 PM	09:42 PM	09:50 PM	10:12 PM	
09:20 PM		09:55 PM	10:00 PM		10:35 PM
	09:40 PM	10:02 PM	10:10 PM	10:32 PM	
09:40 PM		10:15 PM	10:20 PM		10:55 PM
	10:00 PM	10:22 PM	10:30 PM	10:52 PM	
10:00 PM		10:35 PM	10:40 PM		11:15 PM
	10:20 PM	10:42 PM	10:50 PM	11:12 PM	
10:20 PM		10:55 PM	11:00 PM		11:35 PM
	10:40 PM	11:02 PM	11:10 PM	11:32 PM	
10:40 PM		11:15 PM	11:20 PM		11:55 PM
	11:00 PM	11:22 PM	11:30 PM	11:52 PM	

The Operating Plan requires seven vessels to be in service at most times; the Financial Plan assumes that two hovercraft would be available as spares at any time, requiring a total of nine vessels. Maintenance on these two vessels would be conducted at either the Airport or at Moffett Field, which may be a better location in terms of congestion and competing uses.

Operations into the Airport would be conducted as if the craft were a commuter aircraft. The entire operational area would be "sterile," passengers would be screened, and the master would be in contact with the Airport's Air Traffic Control personnel.

Upon leaving either Moffett Field or downtown San Francisco, the hovercraft operator would guide the craft into San Francisco Bay. The route would be in traffic lanes off-shore, far enough to ensure that operational noise is disbursed and does not affect shoreline visitors. At the Airport, the craft would access the airfield from the Seaplane Harbor. Using the ramp at the Coast Guard base, the craft would navigate across the field via Taxiway Q.

Concern has been raised by Airport staff about the suitablity of allowing hovercraft on the airfield. Among the concerns has been the level of dust and debris expelled by the lift fans, the agility and maneuverability of the craft, and their noise impacts. These are all legitimate issues, but the best method to prove or disprove these concerns is to experiment. The Airport is considering a demonstration of hovercraft technology in Summer 1998 to measure these impacts.


Canadian Coast Guard AP-1-88 slated for demonstration

However, even prior to the demonstration, the consultants have concluded that to ensure a highly safe operation, the hovercraft should be attached to an aircraft tug on the Coast Guard base. The tug would then pull the

hovercraft into an area near Gate 75, in the area between the North Terminal and the new International Terminal. The total on-land length is about 1.1 miles (1.75 km).

In the longer term, should the Airport construct a new runway further into the Bay, then there may be adequate property available to construct a guideway for hovercraft north of Taxiway Q. Such a guideway would essentially require about a 50 foot wide right-of-way, with two three foot wide berms, each about three feet high, and a slightly concave forty-four foot guideway. The preferable paving material would be grass.

TERMINALS

Terminals are proposed in downtown San Francisco at the Agricultural Building, south of the Ferry Building, and at Moffett Field, between the Golf Course and the runways. Full architectural cost estimates are included in Appendix A.

SFO TERMINAL

At the airport, a facility would be provided in the vicinity of Gate 75, located in the North Terminal adjacent to the new International Terminal. The facility would be similar to an airport waiting area lounge with jetway access to the hovercraft.

SAN FRANCISCO — AGRICULTURAL BUILDING


State Agricultural Building

This analysis only considers the impacts of frequent airport ferry operation at the Agricultural Building, but another alternative for the San Francisco terminal is Pier 1 1/2, located between Pier 1 and Pier 3, which is also an acceptable location. At the Agricultural Building facilities would be provided for passenger check-in, security screening, baggage handling, and passenger waiting. Additional facilities would be available for passenger concessions, and on the second floor, a restaurant and offices could be provided. A total of 30,000 square feet is assumed at the Ag Building, with about 20,000 square feet devoted to airport ferry uses.

The facility has been designed for between 5,000 to 6,000 daily passengers, well above estimates but still allowing for passenger growth. The assumed daily passengers is about 4,000, with a maximum of 400 passengers arriving in any one hour (the consultants assume that arrivals — those passengers from the Airport, will be more concentrated than departures).

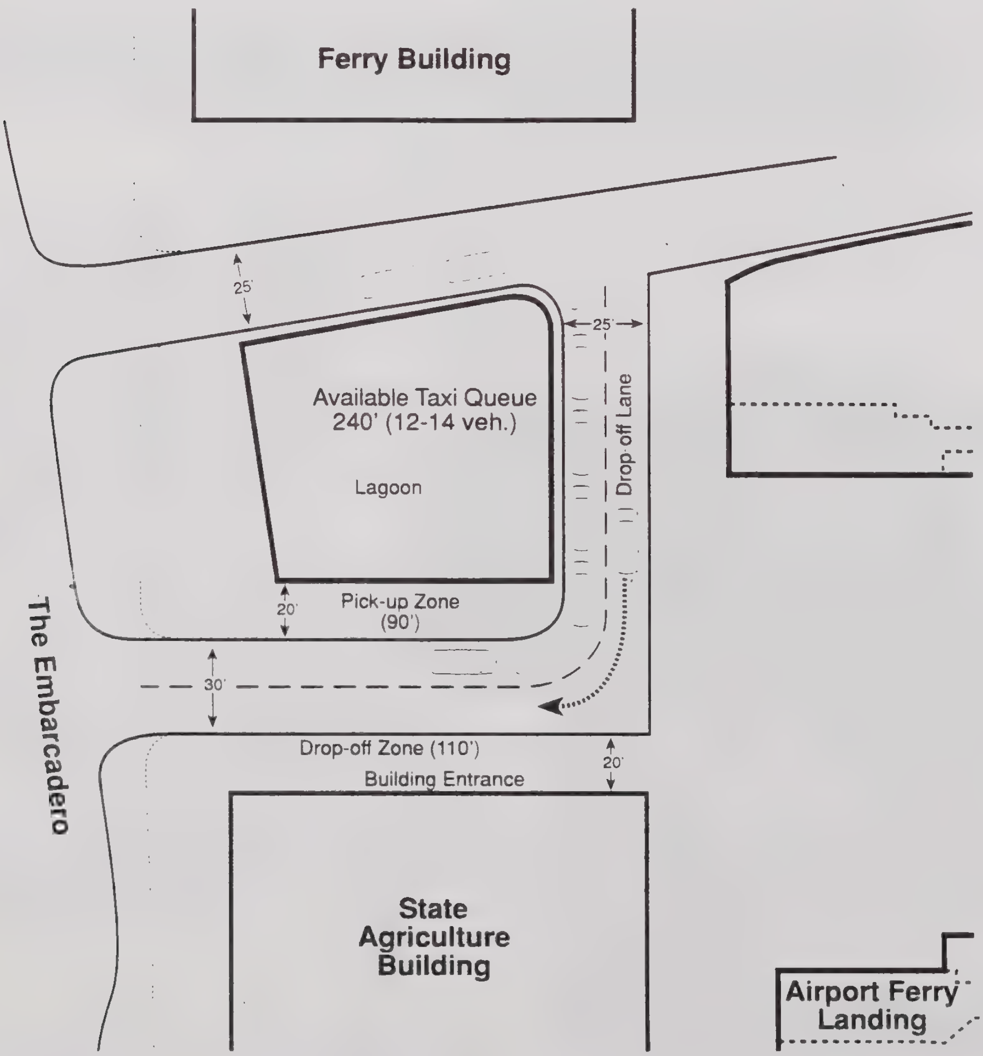
TRAFFIC ISSUES - AGRICULTURAL BUILDING

Assuming 400 passengers per hour, and further assuming that 75 percent use taxis at 1.5 people per cab, each hour would require about 180 taxicabs (or about 60 per vessel arrival).

At a maximum of one minute per pick-up, and assuming 60 taxis were available to serve the terminal, it would take about 15 minutes to load all passengers from the ferry into taxis. A more reasonable assumption would provide for the median taxicabs required per vessel trip, more on the order of 12 to 15 cabs.

It should be noted that even under the most optimistic ferry patronage projections, the Embarcadero is more than adequate to serve even the highest level of taxi and automobile drop-off traffic.

To accommodate both taxi and auto drop-offs, a passenger drop-off zone would be located on a 20 foot sidewalk immediately adjacent to the north side of the Agricultural Building. This zone would be about 110 feet in length, allowing for simultaneous use by about five or six vehicles. The passenger pick-up zone would be located on the north side of a 30 feet wide driveway across from the drop-off zone. This pick-up zone would be on a 20 feet wide by 90 feet ong sidewalk area. This zone would allow simultaneous pick-up by about four or five vehicles.



In addtion to the drop-off and pick-up zones, a 24 feet wide driveway would be constructed on a new water-coverage on the easterly side of the lagoon. This driveway, combined with the passenger drop-off and pick-up zones, would provide the Airport Ferry Terminal with a vehicle and pedestrian area separated from the remainder of activities planned for the Port of San Francisco downtown Ferry Terminal. The proposed "South Promenade" for example, would not be impacted by the driveways to the Airport Ferry Terminal.

Total cost for Agricultural Building improvements would be about $10 to $11 million.

MOFFETT FIELD

The NASA/Ames Moffett Field Airport Ferry Terminal would be located near the Moffett Field Golf Club in the northeasterly corner of the Moffett Federal Airfield (Moffett Field) property. In addition to the vessel boarding facilities, the terminal would include a parking lot located in the southeast quadrant of the intersection of Macon Road with North Patrol Road. The location of the terminal and the major access routes is shown on page 48.

TRAFFIC ISSUES - MOFFETT FIELD

Based on a projection of 1,000 to 1,200 ferry passengers per day using the Moffett Field terminal, and assuming 1.25 persons per vehicle and an average stay of two to three days, the parking lot at the ferry terminal would need to accommodate about 2,000 cars. A 2,000 car parking lot requires an area of about 16 acres. As shown in the figure below, such an area is available adjacent to the proposed terminal site. The proposed parking area is unused except for a single bunker number 581. Bunker 581 should be removed to properly develop the ferry terminal parking lot.

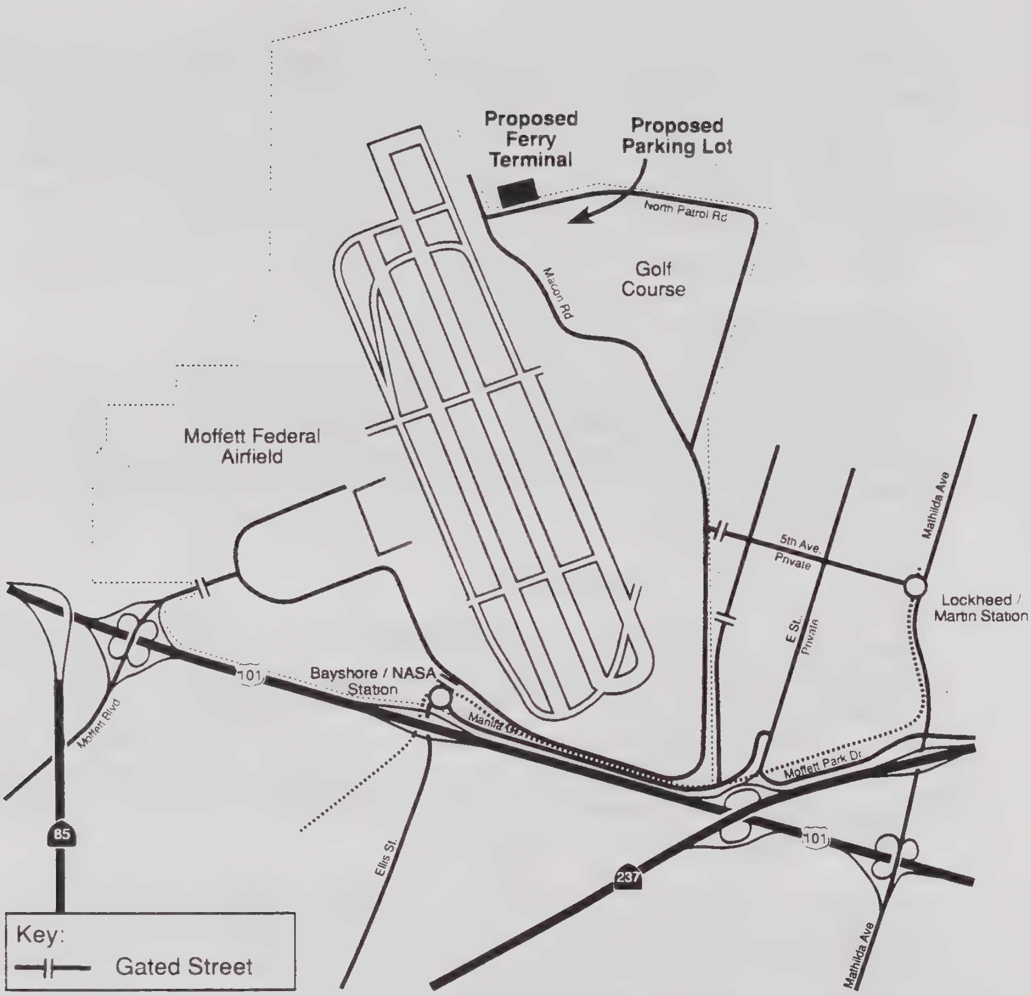
The parking lot layout would require no more than a four minute walk from the most distant parking space to the terminal. A shuttle bus should be provided to ensure that all passengers, including the disabled, are able to use the airport ferry terminal.

Regional access to the proposed airport ferry site is provided by the U.S. Highway 101, State Route (SR) 84 and SR 237 freeways. Highway 101 connects the site with the San Francisco Peninsula to the north and with San Jose and other cities to the south. SR 84 provides access to the southerly portion of the Silicon Valley. SR 237 connects the airport ferry terminal site with the East Bay.

The primary existing local access route to the airport ferry terminal site is via Macon Road and South Macon Road to Ellis Street, the South Gate at Moffett Field. The Highway 101 freeway interchange with Ellis Street is located just 700 feet south of the Moffett gate. Ellis Street experiences some existing congestion at the Moffett gate and at the intersections with the Highway 101 freeway ramps.

The freeway frontage road, Manila Drive, intersects Ellis Street between Highway 101 and the Moffett gate. The City of Mountain View Traffic Engineer has identified the intersection of Ellis Street with Manila Drive as a potential location where a traffic signal may be needed in the near future. Traffic generated by the ferry terminal project could add to the need for such a traffic signal.

Existing access to the proposed ferry terminal site is limited by the security fences in place at Moffett Field and at the Lockheed Martin Corporation (Lockheed) campus that is located immediately east of Moffett Field. For the airport ferry to function properly, a local access



route, not encumbered by security gates, needs to be provided between the regional freeway system and the terminal site.

The following proposed local access routes to the airport ferry terminal assume that a direct ungated street system can be provided either through a portion of Moffett Field and/or through the Lockheed campus. As shown on the following table, the quickest driving time from the airport ferry terminal to the freeway system would be about five and one-half minutes. This shortest route would be from the terminal site to the SR 237 interchange with Mathilda Avenue.

The shortest route to Mathilda Avenue would make use of Macon Road within the limits of Moffett Field and would use Fifth Avenue to cross the Lockheed campus. Because Fifth Avenue is a private street owned and operated by Lockheed, Lockheed Corporation would have to grant permission for the general public to make use of this street. This route would also require that the Moffett East Gate be opened to the general public and that Macon Road, or a parallel street such as Patrol Road, north of Fifth Avenue, be operated as an unsecured area.

TABLE 17
MOFFETT FIELD AIRPORT FERRY
LOCAL ACCESS ROUTES TO THE REGIONAL FREEWAY SYSTEM
ASSUMES ALL STREETS LISTED ARE OPERATED AS PUBLIC ROADS

From the Ferry Terminal Site to:	Distance	Driving Time
SR 237 Mathilda Avenue interchange Via Macon Road, Fifth Avenue to Mathilda Avenue	2.3 miles	5 minutes 35 seconds
Highway 101 Mathilda Avenue interchange Via Macon Road, Fifth Avenue to Mathilda Avenue	2.8 miles	6 minutes 40 seconds
Highway 101 Ellis Street interchange Via Macon Road, Manila Drive to Ellis Street	3.0 miles	6 minutes 0 seconds
Via Macon Road, Fifth Avenue, Mathilda Avenue and SR 237 to Highway 101	4.0 miles	7 minutes 40 seconds

Source: Robert L. Harrison Transportation Planning

The SR 237 Mathilda Avenue interchange would be most convenient for traffic to and from the East Bay and for traffic coming from Mountain View or from the south on SR 85.

Traffic coming from south of the ferry terminal site on Highway 101 would use the Mathilda Avenue interchange with that freeway. Driving time from the Highway 101 Mathilda Avenue interchange to the terminal would be under seven minutes. Again, this access route assumes the use of Fifth Avenue through the Lockheed campus and unrestricted passage through the East Gate of Moffett Field.

For traffic to and from north of the ferry terminal site, the Ellis Street interchange with Highway 101 would provide the most direct access. Driving time from this interchange to the ferry terminal would be about six minutes. This access route assumes that Macon Road within Moffett Field, or a new parallel street constructed just outside the secured area, would intersect with Manila Drive at the southeast corner of the federal property. Use of the existing roadway assumes that the most easterly portion of the federal property, including Macon Drive and the golf course, would be operated outside of the secured area and new gate would be constructed between Macon Drive and the remainder of the secured section of Moffett Field.

The Ellis Street interchange with Highway 101 would provide the most efficient access to the airport ferry terminal for all drivers should the use of Fifth Avenue across the Lockheed campus not be possible.

The Tasman Light Rail Project is now under construction adjacent to Moffett Field and the Lockheed campus. The project will extend the Santa Clara Valley Transit Authority light rail transit service from its existing terminus near Great America in Santa Clara to downtown Mountain View. Two stations are planned in the Moffett Field area:

1. The "Lockheed Martin" station will be located at the intersection of Mathilda Avenue and Fifth Avenue, about two miles from the airport ferry terminal site.

2. The "Bayshore NASA" station will be located at the intersection of Manila Drive and Ellis Street, about three miles from the airport ferry terminal site.

The distances from the light rail stations are too great to allow walking access to the airport ferry. However, should a parking lot shuttle be provided at the ferry terminal, it would be possible to have the shuttle respond on demand to potential ferry passengers when they arrive at a light rail station. The shuttle would also transport airport ferry passengers to the light rail service.

JURISDICTIONAL CONCERNS

Both the Cities of Mountain and Sunnyvale have studied the access problems at Moffett Field and at Lockheed. The Moffett Field Comprehensive Use Plan Draft Environmental Assessment was prepared in 1994. The Lockheed Martin Corporation Master Use Permit Environmental Impact Report (EIR) was certified by Sunnyvale in 1994.

The airport ferry terminal would generate about 900 to 1000 daily and 90 peak hour vehicle trip ends. This trip generation compares to the more than 20,000 daily and 2,400 peak hour trips currently generated at Moffett Field. The airport ferry terminal would cause about a 4% increase in vehicle trip making at Moffett Field. While these vehicle trips would add to the local access roads at Moffett, most of the airport ferry terminal trips would be vehicles already on the regional highway system. The removal of these trips from Highway 101 between Moffett Field and the airport would be a major traffic operations advantage of the proposed airport ferry system.

The Lockheed EIR projects that Mathilda Avenue will be at capacity due to planned new developments. Sunnyvale staff believe that any additional traffic generation will cause problems and may require mitigation. It is not clear whether the limited trips that would be generated by the airport ferry terminal project would trigger the need for additional mitigation measures. Mountain View traffic staff note that a traffic signal at the intersection of Manila Drive and Ellis Street may be needed in the near future. Again, it is not clear that the limited number of trips that would be generated by the airport ferry terminal would be great enough to require installation of a traffic signal at this location.

Costs: Total costs for the Moffett Field facility are estimated between $2 million and $3 million. This includes the cost of the terminal and the parking lots.

CONCLUSIONS AND NEXT STEPS

"The easiest way to go under in this business is to be convinced that all you have to do is be innovative, aggressive, market driven and have a great paint scheme...we have survived because we have been enthusiastic but disciplined...Bankruptcies occur usually due to revenue shortfalls, not cost overruns. Over-optimistic bids create financial cripples..."[8]

Henry Posner III

This study has analyzed the market potential, financial feasibility and operational viability of operating amphibious hovercraft service between downtown San Francisco, Moffett Field and San Francisco International Airport. The authors have attempted to make a conservative estimate of the market and a realistic estimate of the costs. This study makes the following findings:

1. There is market demand for a fast waterborne shuttle service between the Airport and downtown San Francisco and Moffett Field.

   Estimated Daily Passengers between downtown San Francisco and SFO: 3,675
   Estimated Daily Passengers between Moffett Field and SFO: 1,200

   These patronage estimates do not include visitors to the Bay Area, representing about 60 percent of SFO users. As such, these estimates are conservative.

2. The operation between between the Airport and downtown San Francisco and Moffett Field would be profitable.

Downtown San Francisco

	Daily	Annual
Est. Passengers	3,675	1,102,950
Est. Fare Revenue	$36,765	$11,029,500
Est. Operating Cost	$27,000	$8,100,000
Profit/(Loss)	$9,765	$2,929,500

Downtown San Francisco & Moffett Field

	Daily	Annual
Est. Passengers	4,892	1,467,608
Est. Fare Revenue	$48,920	$14,676,075
Est. Operating Cost	$53,000	$15,900,000
Est. Daily Parking Rev.	$8,000	$2,400,000
Profit/(Loss)	$3,920	$1,176,075

3. Operational issues appear to be workable, but require a demonstration before full-scale commitment by the Airport.

4. Environmental and noise impacts, especially at Moffett Feild, require additional study, but do not appear insurmountable.

5. Freight may be a significant revenue generating source, especially for a combination passenger/freight hovercraft from Moffett Field.

6. Terminals would cost a total of $12 to $15 million and are not included in the financing plan.

NEXT STEPS

1. The Airport Commission should appoint a Project Manager to oversee and supervise all aspects of the Airport Ferry Project.

2. The Airport should arrange for a demonstration of hovercraft technology to determine if the craft can be operated safely on the SFO airfield.

3. Should the demonstration be successful, the Airport should solicit the private sector for expressions of interest in the service. When a qualified operator is selected, then the Airport and the operator should actively seek Title XI loan guarantees to purchase the vessels.

4. During the financing period, the vessel operator should work with the various regulatory agencies to gain approval for the operation and terminal construction associated with the project.

5. The initial hovercraft operation should be between downtown San Francisco and SFO with three trips hourly in each direction using a tug escort.As the airport's new runway proposal proceeds, a "guideway" for the hovercraft service should be identified and provided. Additional service could then be scheduled, including the initiation of Moffett Field service, and the tug escort can be eliminated.

ENDNOTES

1 SFO 1996 year-end passenger reports: John F. Brown passenger forecasts.
2 All air traffic figures from FAA 1995 reports or from individual airports.
3 Conversation with Mike McGurl, Harbor Express, Quincy, Massachusetts, December 3, 1997.
4 Conversation with Tom Hannan, Office of Ferry Transportation, Port Authority of New York and New Jersey, November 12, 1997.
5 Metropolitan Transportation Commission, Oakland, California, Regional Ferry Plan, September 1992, written by Pacific Transit Management Corporation.
6 Metropolitan Transportation Commission, Oakland, California, 1995 MTC Airline Passenger Survey, February, 1996, written by J.D. Franz Research.
7 Study of Airport Access Mode Choice, by Greig Harvey. Journal of Transportation Engineering, vol. 112, No. 5, September 1986.
8. "Underdog Railroading: The Posner Principal" Frank Wilner, Railway Age, May 1998

CREDITS

Pacific Transit Management Corporation wishes to thank the following individuals for their assistance with this project:

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George Teebay, Federal Security Manager, SFO
Daniel Blythe, Manager, San Francisco Control Tower Manager

Canadian Coast Guard

Commander John McGrath

NASA/Ames Research Center

Donald James, Office of External Affairs

APPENDIX:

AIRPORT FERRY STUDY 1998: TERMINAL COST ESTIMATES


© Hoverworks, UK

MAY 29, 1998

PREPARED BY:
PACIFIC TRANSIT MANAGEMENT
BERKELEY, CALIFORNIA

Agriculture Building Renovation For
Hovercraft Terminal
Port of San Francisco

Cost Estimate by Art Anderson Associates
March 2, 1998

CSI Division	Cost
Division 1 - General Requirements	$ 670,000
Division 2 - Site Work	$ 2,590,000
Division 3 - Concrete	$ 80,000
Division 4 - Masonry	$ 505,000
Division 5 - Metals	$ 165,000
Division 6 - Wood & Plastics	$ 190,000
Division 7 - Thermal and Moisture Protection	$ 315,000
Division 8 - Doors & Windows	$ 205,000
Division 9 - Finishes	$ 655,000
Division 10 - Specialties	$ 135,000
Division 11 - Equipment	$ 70,000
Division 12 - Furnishings	$ 250,000
Division 13 - Special Construction	$ 0
Division 14 - Conveying Systems	$ 45,000
Division 15 - Mechanical/HVAC	$ 595,000
Division 16 - Electrical	$ 885,000
Subtotal	$ 7,355,000
General Contractor Overhead/Profit/Bond/Insurance (8%)	$ 590,000
Total Construction Cost	$ 7,945,000
Change Order Contingency @ 10%	$ 795,000
Architect/Engineering Fees @ 8% of Total Construction Cost	$ 635,000
Construction Admin. Fees @ 4% of Total Construction Cost	$ 320,000
Miscellaneous Permits, Testing and Utility Fees	$ 80,000
Total Evaluated Construction Costs	$ 9,775,000

Summary of Major Materials and Systems

DIVISION 1 - GENERAL REQUIREMENTS

SUMMARY OF WORK:	Will identify the Work involved in the Project and the Type of Contract. Describes the scope of the Construction Work.
SUBMITTALS:	General procedures and requirements for submittals. Specific requirements for submittals are included in the individual specification sections. Provides listing of submittals required for the Project.
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS:	Establishes the requirements for temporary utilities, temporary construction and support facilities. Establishes the parameters for construction fencing and barricades. Section includes requirements for installation, maintenance and removal.
PROJECT MEETINGS:	Establishes the requirements for routine project status and coordination meetings throughout the construction period.
SUBSTITUTIONS:	States the procedures for requesting substitutions and product options.
CONSTRUCTION WASTE MANAGEMENT	Establishes the requirements for the recycling requirements and disposal requirements of construction debris.
FACILITY START-UP/COMMISSIONING	Establishes contractor requirements for detailed start-up, adjustment and testing of all building components and systems within the facility.
CONTRACT CLOSE-OUT:	Establishes the requirements for substantial completion inspection, final inspection, warranty inspections, close-out submittals, operating and maintenance manuals, etc. at the completion of the Project.

DIVISION 2 - SITE WORK

DEMOLITION:	Specifies removal of those construction elements that are not required in the construction of the new facility and it's utilities. Also describes the extent of the gutting of the existing building interior.
EARTHWORK:	Excavation, backfill and grading of the site to accommodate the proposed new utilities and exterior walkway repairs.
SEWERAGE AND DRAINAGE:	Specifies materials and requirements for sanitary and storm drain systems and their connections to City utilities.
PILINGS:	Describes the methods used to repair, replace and seismically brace the pilings; add new pilings as required to support the renovation layout.
SITE IMPROVEMENTS:	Specifies exterior site furnishings including benches and plant containers.

DIVISION 3 - CONCRETE

CAST-IN-PLACE CONCRETE:	Specifies material and installation requirements for miscellaneous concrete repairs to slabs, sidewalks and pier deck.

DIVISION 4 - MASONRY

CONCRETE MASONRY UNITS:	Describes the installation of the cmu wall around the perimeter of the hovercraft bay to provide acoustical and fire separation from the balance of the building.
MASONRY REPAIRS	Specifies the required procedures for repairing, replacing, cleaning, and sealing the existing masonry exterior. Includes tucking and repointing of masonry joints.

DIVISION 5 - METALS

STRUCTURAL METAL FRAMING:	A 36 grade steel framing for support of new building loads that are the result of removing columns and replacing with girder trusses. Also, miscellaneous steel framing, clips, and connections required for structural reinforcement, shear wall connections, and seismic bracing.
COLD FORMED METAL FRAMING:	A 36 grade cold formed steel shapes for all interior and exterior structural framing as necessary.
EXPANSION CONTROL	Specifies materials and installation requirements for expansion joints in the pier deck.
STEEL STAIRS	Prefabricated steels stairs with concrete treads and landings.

DIVISION 6 - WOOD AND PLASTICS

ROUGH CARPENTRY:	General framing for blocking and miscellaneous support as required.
CUSTOM CASEWORK:	Plastic laminate clad wood cabinets per American Woodworking Institute Standards as required in at check-in counters and vendor spaces.

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

WATERPROOFING/DAMP PROOFING:	Bentonite boards and asphaltic coating for waterproofing and sealing underground concrete surfaces such as at the elevator pit.
INSULATION:	Rigid roof and batt wall the insulation products as required to meet the California Energy Code.
FIRESTOPPING:	Firestopping materials such as sealants meeting U.L. Testing Standards for the intended application to prevent the spread of smoke and fire between spaces.
CONCRETE TILE ROOFING:	Includes the cleaning, repair and replacement of the existing tiles, including accessories.

MEMBRANE ROOFING:	Modified bituminous sheet roofing installed per National Roofing Contractor Association Standards at the flat portions of the roof.
FLASHING AND SHEET METAL:	Steel sheet products including flashing reglets and counter flashing installed at locations where the flat roof intersects with the parapets and exterior walls, exterior wall penetrations, and as needed for replacement at the tile roof, per the recommendations of the National Roofing Contractors Association and SMACNA.
JOINT SEALANTS:	Two component polyurethane exterior sealant, and acrylic latex interior sealant. Silicone sealant to be provided in "wet" locations.

<u>DIVISION 8 - DOORS AND WINDOWS</u>

STEEL DOORS AND FRAMES:	Doors and frames to comply with Steel Door Institute Standards. To be used at exterior locations and in higher security areas and in areas of utilitarian nature.
FLUSH WOOD DOORS:	Solid Core interior wood doors with hardwood veneer finish per American Woodworking Institute requirements for office areas, and some public areas such as restrooms.
COILING DOORS AND GRILLES	Motorized overhead coiling door, primed and painted will be used to close the hovercraft bay entrance.
ENTRANCES AND STOREFRONTS:	Anodized aluminum storefront frame sections will be provided at the new pedestrian entry/exit locations. The frames will support clear one inch insulated glass units, and depending upon the glass application, will be tempered as required by code. Pneumatic door opener will be provided where required by ADA.

HARDWARE:	Heavy duty type as required for security and operation of each door. Hardware to be keyed per a master key system. Some security hardware such as electric strikes and card key entry systems may be required. Weatherstripping, smoke seals, panic hardware, thresholds, etc., as required by code or use.
WINDOWS	Replace existing exterior windows with new windows matching the original windows in material and configuration. The new windows can accommodate 1" insulated glazing.
GLAZING	Replace the existing exterior glass with 1" insulated, low-e tinted glazing. Interior windows, if any to be 1/4" tempered glazing set in hollow metal frames. Wire glass to be used at 1-hour separations.

<u>DIVISION 9 - FINISHES</u>

GYPSUM BOARD SYSTEMS:	Taped and textured five eighths inch Type 'X' gypsum wall board throughout. Wallboard to be applied to light gage steel studs for wall framing, and to steel channels and furring members for suspended ceilings at selected locations. Water resistant wallboard to be used at "wet" locations, and fiberglass reinforced cementitious backer board will be used where tile is specified.
CERAMIC TILE:	Ceramic tile will be applied full height on all restroom walls. Ceramic tile floor and coved base tile to be used on the restroom floors.
ACOUSTICAL CEILINGS:	New two foot by four foot lay-in ceiling panels will be installed in the majority of interior spaces. Upgraded or designer tile to be used in selected locations.
LINEAR METAL CEILINGS	This type of ceiling is intended for installation in the check-in/queuing area of the facility.

ACOUSTICAL WALL TREATMENT:	Fabric covered acoustical insulation will be provided at selected walls in the waiting area to dampen sound.
EPOXY RESINOUS FLOORING:	Epoxy resinous flooring with integral cove base and traction surface will be provided at the baggage handling area.
CARPET:	New roll carpet will be provided. Roll carpet to be used in all offices, selected corridors, and portions of the waiting area. A different color "border" will be used the waiting areas.
PAINTING:	Exterior painting of metals, windows, and miscellaneous trim will be solid color latex stain. Masonry surfaces will be sealed. Interior walls to receive a latex semi-gloss or gloss depending upon location. Interior wood doors to receive a transparent urethane finish.
TERRAZZO FLOORING	Terrazzo flooring is anticipated along major public circulation routes, including the baggage/check-in, baggage claim, and portions of the waiting area, and the hallway leading to the waiting area.

DIVISION 10 - SPECIALTIES

WALL CORNERGUARDS:	Four foot high flexible vinyl corner guards to be installed at exposed fixed partition corners.
IDENTIFYING DEVICES:	Interior directory signs will be provided at main lobby areas. Exterior signage to be wall mounted sign above the buildings main entrance. Interior signs to have name plates or room numbers on doors to lavatories, offices and ancillary spaces. Also included are signage systems for departure and arrival times for the hovercraft, and individual airline counter identification signage.
FLAGPOLE:	Brushed aluminum finish and internal halyard for raising/lowering the flags mounted on the roof top.
FIRE EXTINGUISHERS:	Fire extinguishers in semi-recessed wall mounted cabinets.
TOILET PARTITIONS AND BATH ACCESSORIES:	Restroom toilet compartments will have overhead braced metal partitions with baked enamel finish. Grab bars, paper disposal/dispensers, soap dispensers, coat hooks, etc., as required in the restrooms. Accessible fixtures will have accessories mounted to meet handicap requirements.
TELEPHONE ENCLOSURES	To be provided where indicated on the plan for use by the public.

DIVISION - 11 EQUIPMENT

SECURITY EQUIPMENT	Includes CCTV cameras and monitors, metal detectors and baggage x-ray equipment.
BAGGAGE SCALES	To be installed as part of the modular casework for the passenger/baggage check-in counters.

DIVISION 12 - FURNISHINGS

WINDOW TREATMENTS:	Adjustable horizontal blinds will be installed in the majority of all exterior windows.
FLOORMATS AND FRAMES:	Recessed floor mats will be provided at all points of entry into the building, and will be flush with terrazzo flooring.
MULTIPLE SEATING:	Multiple seating with standard functions and commercial grade materials will be provided in the waiting and check-in areas, and include tables and trash receptacles.

DIVISION 13 - SPECIAL CONSTRUCTION

BUILDING AUTOMATION SYSTEMS:	The Project will require an energy monitoring and control system as well as a security alarm and detection system.
FIRE SUPPRESSION AND SUPERVISORY SYSTEM:	An automated fire suppression and warning system will be provided.

DIVISION 14 - MATERIAL HANDLING SYSTEMS

ELEVATORS:	Automatic, hydraulically operated elevator with plastic laminate interior finishes meeting ASME A17.1 and ADA code requirements.

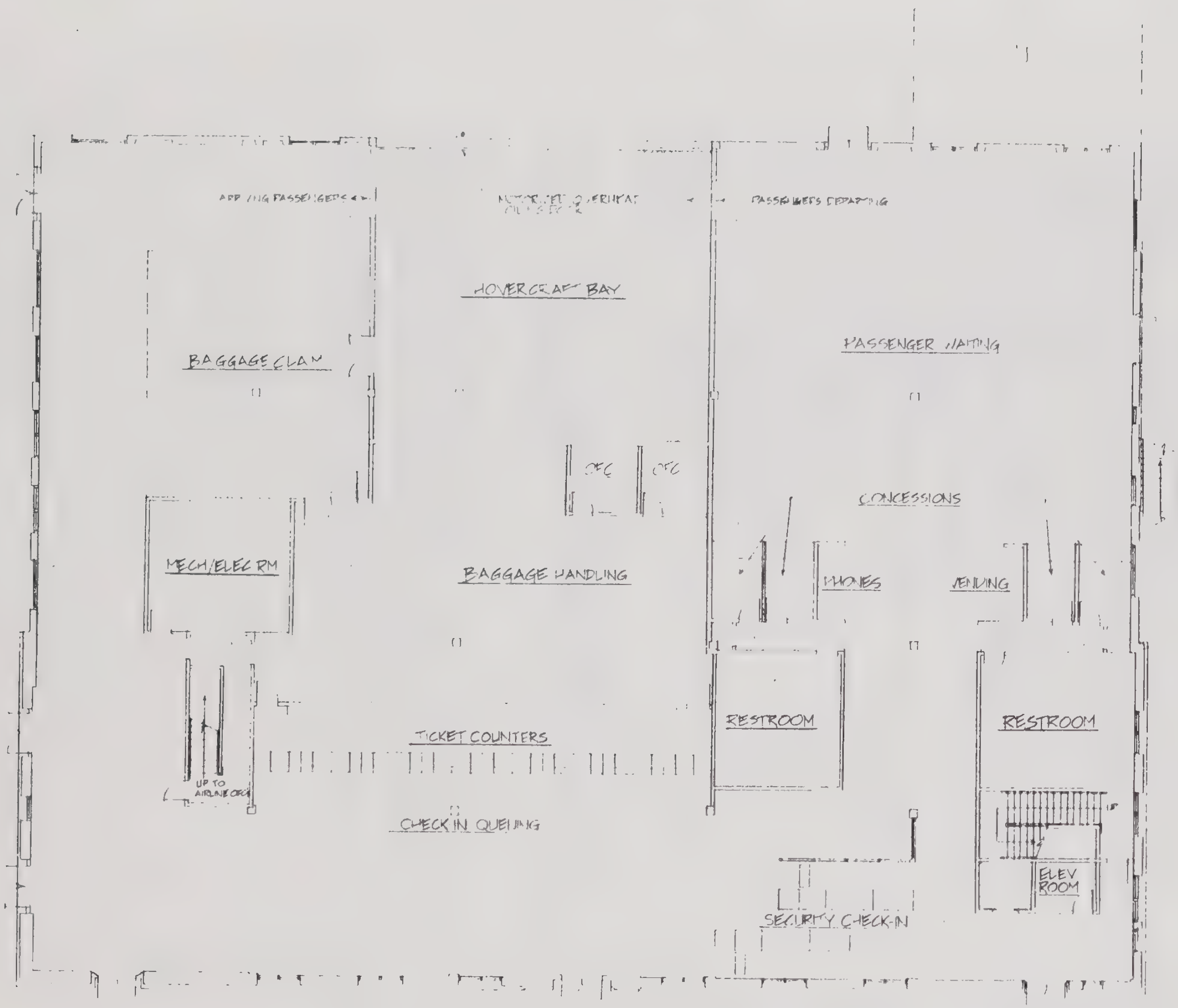
DIVISION 15 - MECHANICAL

MECHANICAL GENERAL REQUIREMENTS	This section includes mechanical general requirements for all sections of Division 15, Mechanical.
MECHANICAL INSULATION:	This section includes mechanical insulation including field-applied insulation for heating, ventilating and cooling (HVAC) air distribution systems and piping systems which are located within, on, under, and adjacent to the building; and for plumbing piping systems.
FIRE EXTINGUISHING SPRINKLER SYSTEM (WET PIPE):	This section will install automatic wet pipe fire extinguishing sprinkler systems for heated areas (unheated areas to be protected by dry sprinkler systems).
PLUMBING SYSTEMS:	This section will provide building plumbing systems including aboveground and buried DWV piping and water piping within and under each building and within 5 feet outside of the building walls.
FUEL GAS PIPING:	This section will provide exterior and interior fuel gas piping.
PACKAGED AIR CONDITIONING UNITS:	This section will provide room air conditioners, and split system VAV heat pumps.
AIR HANDLING EQUIPMENT:	This section will provide air handling equipment including central-station air handlers, fans, (centrifugal fan, propeller fan, vane axial fan, power ventilator, in-line tubular centrifugal fan, propeller ceiling fan, and air curtain), gravity ventilators, fan-coil room units, room air-introduction units, variable-air-volume terminal units, and unit ventilators.
DUCTWORK AND DUCTWORK ACCESSORIES:	This section will provide ductwork and ductwork accessories including diffusers, registers, grilles, louvers, dampers, VAV and fan powered boxes, and louvered penthouses.

DIRECT DIGITAL CONTROL SYSTEMS:	This section will provide direct digital control (DDC) of heating, ventilating, and air conditioning (HVAC) systems.
TESTING/ADJUSTING/BALANCING:	This section will include heating/ ventilating/cooling systems testing, adjusting, and balancing (TAB) of heating, ventilating, and cooling (HVAC) air and water distribution systems.

DIVISION 16 - ELECTRICAL

ELECTRICAL GENERAL REQUIREMENTS:	Includes requirements for permits, fees, submittals and general procedures to ensure use of quality materials and workmanship.
UNDERGROUND ELECTRICAL WORK:	Establishes requirements for underground conduit and wires for 1000 amp service entrance feeder.
INTERIOR WIRING SYSTEMS:	This section deals with switches, raceways, cable trays, telephone/data conduits and boxes, conductors, panel boards and other materials used for interior wiring. Generally switches will be rocker arm with stainless steel covers. Wall outlets will be 120V with stainless steel covers.
INTERIOR LIGHTING:	Designed to comply with California Energy Code requirements. Interior areas to be lay-in 277 V fluorescent lighting with T8 or Biaxial fluorescent lamps with electronic ballasts. Specialty lighting will be required in public areas such as high pressure sodium fixtures with low cut-off optics to minimize light overspill.
INTERIOR FIRE ALARM SYSTEM:	The fire alarm system will consist of smoke and heat detectors interfacing with the mechanical systems, manual pull stations, audio-visual alarms, flow and tamper switches in a fully addressable format. The system will have a means of sending a signal to the fire station.
MASTER CLOCK SYSTEM	Digital, solid-state electronic clock system provided in selected spaces.



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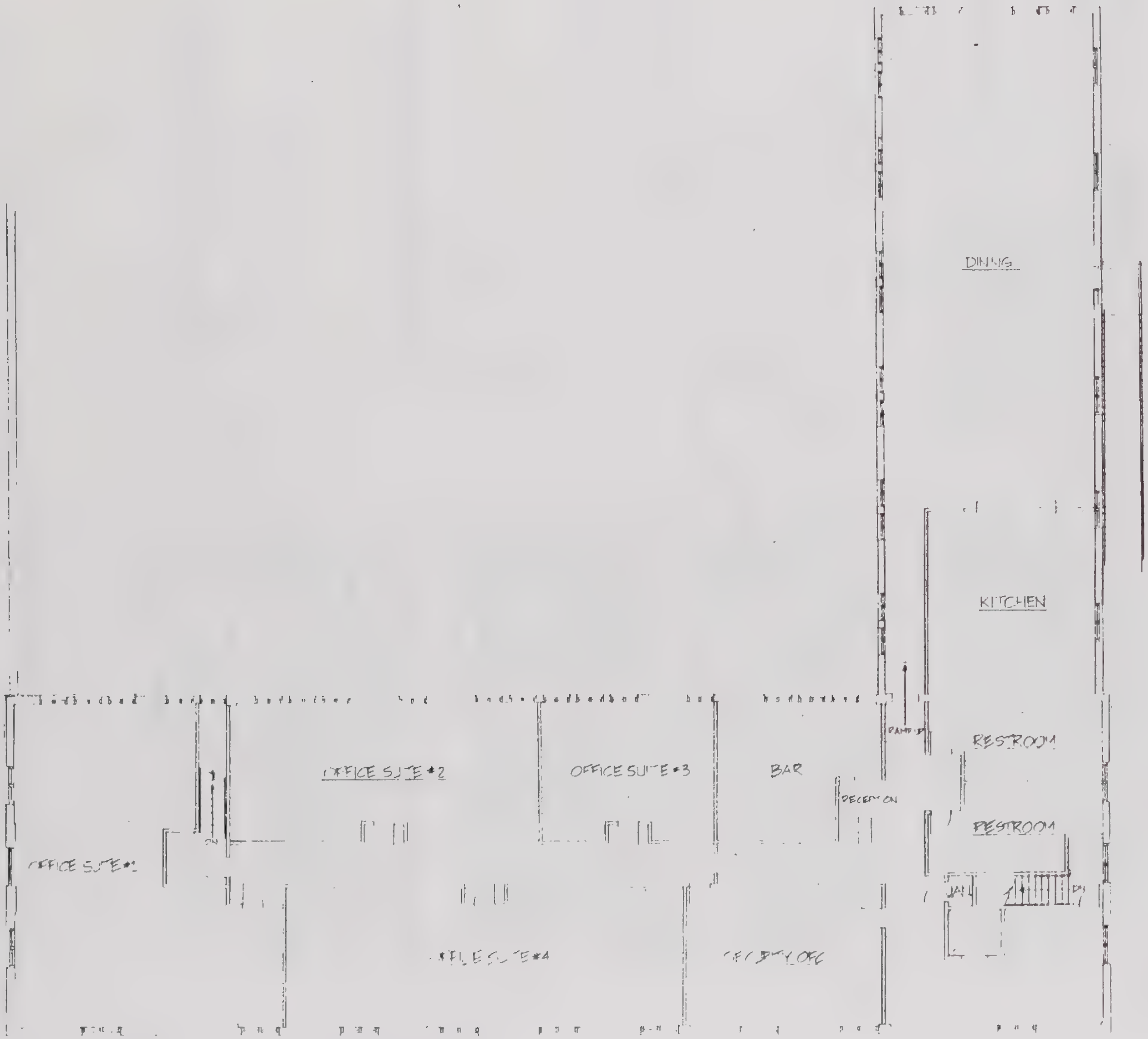
HOVERCRAFT TERMINAL
AGRICULTURE BUILDING
PORT OF SAN FRANCISCO

CHECKED DSL
DATE 3-2-98

FIRST FLOOR RENOVATION PLAN

R-1



HOVERCRAFT TERMINAL
AGRICULTURE BUILDING
PORT OF SAN FRANCISCO

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3-2-96

SECOND FLOOR
RENOVATION PLAN

R-2

New Moffett Field Hovercraft Terminal
Port of San Francisco

Cost Estimate by Art Anderson Associates
March 23, 1998

CSI Division	Cost
Division 1 - General Requirements	$ 180,000
Division 2 - Site Work	$ 80,000
Division 3 - Concrete	$ 45,000
Division 4 - Masonry	$ 0
Division 5 - Metals	$ 210,000
Division 6 - Wood & Plastics	$ 35,000
Division 7 - Thermal and Moisture Protection	$ 110,000
Division 8 - Doors & Windows	$ 90,000
Division 9 - Finishes	$ 285,000
Division 10 - Specialties	$ 120,000
Division 11 - Equipment	$ 35,000
Division 12 - Furnishings	$ 100,000
Division 13 - Special Construction	$ 0
Division 14 - Conveying Systems	$ 0
Division 15 - Mechanical/HVAC	$ 265,000
Division 16 - Electrical	$ 395,000
Subtotal	$1,950,000
General Contractor Overhead/Profit/Bond/Insurance (8%)	$ 155,000
Total Construction Cost	$2,105,000
Change Order Contingency @ 10%	$ 210,000
Architect/Engineering Fees @ 9% of Total Construction Cost	$ 190,000
Construction Admin. Fees @ 4% of Total Construction Cost	$ 85,000
Miscellaneous Permits, Testing and Utility Fees	$ 60,000
Total Evaluated Construction Costs	$2,435,000

Moffett Field Hovercraft Terminal Cost Estimate Assumptions:

The cost estimate assumes a pre-engineered metal structure enclosing approximately 14,000 Sq. Ft. Areas are provided for passenger/baggage check-in, a security check point consisting of an X-ray and metal detector, waiting area for 200 passengers, baggage handling, baggage claim, mechanical room, men and women's restrooms serving both public and staff, and miscellaneous circulation.

DIVISION 1- GENERAL REQUIREMENTS

This is the Contractor's administrative costs to perform the work, and includes submittals, meetings, temporary facilities, quality control testing, project documentation (including meeting minutes, scheduling, certification of payments, daily reports), and contract close-out (record drawings, warrantees and operation and maintenance manuals).

DIVISION 2 - SITEWORK

Demolition of existing paved surfaces is assumed in preparation for siting the structure. Little, if any clearing has been anticipated. Some paving surfaces for a passenger drop-off area and pedestrian walkways adjacent to the building is included.

DIVISION 3 - CONCRETE

The facility is to be founded on conventional spread footings, with a reinforced concrete slab on grade with poured concrete pads at column locations.

DIVISION 5 - METALS

For purposes of this estimate, the building is a light framed steel structure, with steel roof joists and decking as offered by a pre-engineered metal building manufacturer. The framing is to be designed to withstand local earthquake and wind loads. The exterior walls of the facility is protected from the elements using fluorpolymer coated metal cladding over cold formed steel framing. See Division 7 for costs regarding the roof and miscellaneous metal flashings.

DIVISION 6 - WOOD AND PLASTICS

Medium density overlay casework clad with plastic laminate is to be provided at the passenger check-in counters.

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

The roof is a batten seam metal roof with a colored fluorpolymer coating over a vapor barrier, and vented to keep moisture build-up at a minimum. Metal flashing accessories for both the roof and wall cladding is to be provided by the pre-engineered building manufacturer, and costs are included in this section. Fiberglass batt insulation is to be installed in exterior wall cavities. Rigid polyisocyanurate boards with a nailable surface is to be installed beneath the roof batten seam metal roof.

DIVISION 8 - DOORS AND WINDOWS

Exterior doors and windows consist of hollow metal storefront construction. All exterior glazing is to be insulated with a low "e" coating. Interior doors will be solid core wood doors where public access is required, while other doors will be hollow metal leading to non-public areas. All door frames will be hollow metal. All door hardware will be commercial grade.

DIVISION 9 - FINISHES

Interior finishes consist of painted GWB with decorative reglet details over light gage metal framing. Acoustical wall and ceiling treatments to be installed in the public areas. Floors of pigment stained smooth exposed aggregate concrete in a decorative pattern would be installed in the main public circulation areas, including the waiting area. The restrooms have a sheet vinyl flooring with integral abrasive surfacing and roll-up base. All exposed structural metal framing will be painted.

DIVISION 10 - SPECIALTIES

Visual display boards and interior and exterior building signage is to be installed as part of the identification devices for the facility. Floor mounted phenolic toilet partitions, vinyl wall corner guards, flagpole, fire extinguisher cabinets restroom accessories are also included in the cost estimate.

DIVISION 11 - EQUIPMENT

Equipment costs are assigned to the metal detector and X-ray machine at the security checkpoint, and some baggage handling equipment between the check-in counter and the baggage handling area. Also would anticipate solid waste handling equipment.

DIVISION 12 - FURNISHINGS

Furnishings are limited to multiple seating for passengers, including tables and ash urns, and pedestrian walk-off mats.

DIVISION 13 - SPECIAL CONSTRUCTION

See Division 5 - Metals for costs and description of prefabricated metal building shell.

DIVISION 15 - MECHANICAL

Electric packaged air conditioning units and natural gas fired central air handling equipment with ducting are estimated. In addition, this equipment will be controlled by direct digital controls. A fire sprinkler extinguishing system will be installed throughout the facility. Restroom plumbing fixtures and piping are also included.

DIVISION 16 - ELECTRICAL

This division includes underground electrical service and distribution, including transformers, panels, cabling and wireways for switches, outlets, data and telephone. In addition, the interior lighting fixtures and a fire alarm system are part of this division.